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# THOMAS BRAND HOLLIS (1719–1804)

## English Admirer of Franklin and Intimate of John Adams

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IF a man should be judged by the company he keeps and the friends he makes, then Thomas Brand Hollis of the Hyde in Essex should be better known to students of Atlantic history. Hollis's devotion to the American Revolutionary cause will be amply documented by two letters to Franklin, noticed below. His connection with the sage of Philadelphia was, however, only one among many others of much interest. In 1786 he entertained Thomas Jefferson to dinner at his London house. He became an intimate friend of both John and Abigail Adams whilst they were in Grosvenor Square. Some of the letters attesting their close association are still preserved.[1] He commissioned Charles Willson Peale (1741–1827) to paint what is probably the best known portrait of Thomas Paine (1737–1809), and was later responsible for the prints made from it for the *Rights of Man* in 1791. Indeed, George Chalmers (1742–1825), writing as Francis Oldys, A.M. of the University of Pennsylvania, wrongly credited him, as well as William Godwin (1756–1836) and Thomas Holcroft (1745–1809), with a share in that work. To Brand Hollis, Paine entrusted the key of the Bastille, which was to be forwarded to George Washington as a symbol of Franco-American sympathy. Hollis was so constant a friend to liberty and learning in the New World that he was elected in 1783, as soon as hostilities ceased, to the newly established Academy of Arts and Sciences in New England. Four years later, Harvard University bestowed on Joseph Priestley (1733–1804), himself to be a recipient of Hollis bounty, on Richard Price (1723–1791), a close friend, and on Brand Hollis the degree of LL.D.[2] Other intimates and associates were John Jebb (1736–1786), Capel Lofft (1751–1824), Christopher Wyvill (1740–1822), and Major John Cartwright (1740–1824). All were associated by a common devotion to the cause of the colonies and of parliamentary reform. Brand Hollis, his friend Archdeacon Blackburne (1705–1787), Theophilus Lindsey (1723–1808), Sir George Savile (1726–1784), and others supported varied attempts for greater religious liberty, both within and without the Established Church. Law reform was another good cause with which Brand Hollis was concerned, and he introduced Samuel Romilly (1757–1818) to Mirabeau, as well as to Jefferson. He maintained his sympathy with the French when both Adams and Edmund Burke were becoming increasingly nervous about the progress and character of the Revolution.[3] In short, Brand Hollis was an English radical republican, active in support of every reforming movement during the last half of the eighteenth century, and none the less to be commended for his efforts, though these were entirely unrewarded by success or recognition.

Brand Hollis's life, work, and connections illustrate vividly the bonds that bound Americans and their sympathizers with almost all progressive political and religious circles in contemporary England. Sylas Neville (1740–1840), an enthusiastic supporter of the colonial cause, lamented in 1767 that corruption, prejudice, and want of thought limited his fellows only to Brand (who added the name of Hollis in 1774), William Strahan (1715–1785), the printer, Richard Price,

[1] *Memoirs of Thomas Brand Hollis, esq., F.R.S. & S.A.* (by John Disney), London, 1808. Hereafter, simply *Memoirs*. All biographical details about Hollis are from this source unless otherwise noted. The letters from Adams are pp. 30–40, note L to p. 13.

For the dinner party, 15 April 1786, attended by Adams and Jefferson, see C. F. Adams, ed. *Works of John Adams* **3**: 396, Boston, 1865; *ib.* 401–405, dated 24–28 July, for Adams's visit to the Hyde. Three of the Adams letters used by Disney are printed in *ibid.* **9**: 557, 568, 569.

[2] *Mass. Hist. Society, Proc., 1909–10* **43**: 609–646, 1910. Letters from Price, Priestley, Lettsom, and Brand Hollis to President Willard (at Harvard 1783–1818), hereafter referred to as the Willard Letters.

For the note about the key to the Bastille, see *ib.* p. 631. On the Peale portrait of Paine, see M. D. Conway, *The Life of Thomas Paine* **1**: 284; **2**: 474, N. Y., G. P. Putnam & Sons, 1908. Disney's *Memoirs* print the Harvard diploma to Brand Hollis, which Adams gave him, p. 41.

[3] Elie Halévy, *The Growth of Philosophical Radicalism* (tr.), 75 and 146, N. Y., Macmillan, 1928.

economist and divine, and the Hollis family.[4] Neville somewhat underestimated the pro-Americans. His own *Diary* elsewhere mentions others, but he was rightly aware of the fundamental difficulty caused by the decline of liberal sentiment even amongst the Whigs, and by the impossibility of inspiring the unreformed Commons to any constructive action on representation, religious liberty, or colonial problems. Chatham, indeed, achieved the repeal of the Stamp Act, but in the next decades, as he sickened and died, not only was this success negated, but all attempts at other reform were doomed to failure.

The claims of Englishmen to political liberty were remembered and were extended to the colonial area in the eighteenth century by men like the Irishman, Robert Molesworth (1656–1725), John Trenchard (1662–1723) and Thomas Gordon (d. 1750) of *Cato's Letters,* with its famous essay on *Colonies and Plantations,* were revered by Franklin. Sects of the Glasgow School, of the persuasion of John Campbell (1708–1775), author of *Liberty and Right,* James Burgh (1714–1775), whose *Political Disquisitions* reflected deep dissatisfaction with both colonial and domestic policies, and any number of printers from the North, who brought out reforming tracts, maintained, together with some few Englishmen like Savile, the great traditions of seventeenth-century thought. They were, however, never able to achieve the smallest parliamentary victory, and their chief success may be said to lie in the preservation and adaptation of the old "Revolution Politick," which did so much to inspire both the Founding Fathers of America and the Continental reformers of the Enlightenment. Ministers paid little attention to popular opinion during the Wilkes commotion or during the eighties, except when it degenerated into violence. They could ignore the freeholders of Yorkshire, Essex, or the voters of Westminster agitating for increased representation. No measure of franchise reform nor increasing religious liberties passed through the eighteenth-century Parliament, except for the very meager concession to Catholics in 1778 and the disappointing economical reform sponsored by Burke in 1782. There was neither oppression nor ignorance amongst the literate classes. A free press discussed public problems and personalities frankly. Interest in the extension of liberty was scant. Only the efforts of a minority devoted to the great tradition kept alive the earlier ideals of freedom. A man like Brand Hollis illustrates the activities, sympathies, politics, and frustrations of what may be called the early radicals, or, more properly, the last of the classical republicans of an earlier century.

The Brands at the beginning of the eighteenth century were London mercers. After engaging for some time in the family business, Timothy Brand bought an estate at the Hyde, near Ingatestone in Essex, and became a country gentleman. He had two daughters, one of whom married a Richard Grindal. His son Thomas, afterwards the heir of Thomas Hollis of Lincoln's Inn (1720–1774), was born in 1719, a year after the purchase of the Hyde. He was educated at Brentwood nearby, and then at Felsted. His name was entered for Inner Temple in 1735, although he did not take up residence there until 1741, after he had matriculated at the University of Glasgow and had resided in that city for three years. The Brands were Dissenters and, therefore, barred from Oxford and Cambridge. During the lifetime of Francis Hutcheson (1694–1746), professor of moral philosophy for the last seventeen years of his life, Glasgow became a rival to Leyden, and many were drawn thither by the fame of his teaching. Hutcheson's students "panted to be like him." Some followed him into academic life. Leechman memorialized him; Adam Smith, who eventually succeeded to his professorial chair, praised him; David Hume sought his advice; the diarist, "Jupiter" Carlyle (1722–1805), testified to his charm and originality; Robert Foulis (1707–1776) and Richard Baron (d. 1768), famous among other things for the republican works they published or edited, had sat at his feet and read those "liberty tracts" he recommended. These were Brand's contemporaries. With another, Douglas, Earl of Selkirk (1722–1799), he commissioned a likeness of their preceptor whilst they were in Italy. This and some fifteen volumes of Hutcheson's works he was to send to his Alma Mater seven years before he died. John Adams noticed the many mementoes of the Scots philosopher when he visited the Hyde in 1786, and was given a volume or two of his works as he sailed for America in 1789. Adams was interested not only in these, but also in Marcus Aurelius, translated by Hutcheson and a colleague, James Moor, in 1742, and significant in the development of English and American thought.

This favorite professor found immortality in the hearts and lives of his students: in Adam Smith,

[4] Basil Cozens-Hardy, ed., *The diary of Sylas Neville, 1767–1788,* 51, London, Oxford Univ. Press, 1950.

in many an "ultra" Whig or republican like Baron and Brand, in the politics (if not the theology) of John Witherspoon. What did he teach? He taught that liberty of conscience is an inalienable bulwark of liberty and that liberty itself is grounded in our sense of right. Knowledge and freedom are necessary for happiness and virtue. Our own conscience and sense make us realize the harmony between our own and the general good, the happiness of the greatest number. The state must provide for mutual good offices and must avoid infringing the rights of the individual to life, safety, work of any kind not injurious to others, property, and the fruits of labor. Hutcheson follows Harrington in a desire for rotation in public office and extends his ideas on representation. Since the end of all political union is the good of the governed, Hutcheson maintains stoutly a right to resist oppression, even on the part of the colonies whose tacit conventions tie them to the mother country. His is the most emphatic statement of colonial rights before those of Franklin and Burgh, and is in no way exceeded by them. There can be no question that many of the radical ideas of Brand and his friends may be traced to the teaching at Glasgow in their youth. Hutcheson drew directly from Harrington, Richard Cumberland, Hugo Grotius, Samuel Puffendorf, and the good third Earl of Shaftesbury. He extended and developed many of their political ideas in his lectures. He acknowledged his debts to them and to others; indeed, if the books he recommended to his students be included, he must be considered one of the chief links in the passage of libertarian ideas from the seventeenth century to his own.[5]

Brand left Glasgow for the Inns of Court, to continue his education there by private reading. In July 1748 he and his friend Thomas Hollis, also a resident in the Inns, set out for two tours of the Continent. The first they made together in Holland, France, Switzerland, and Italy, returning in December 1749. The second, by mutual consent, they made apart, meeting only occasionally. Brand was abroad until 1753. On his return he became a Fellow of the Royal Society and other learned bodies, including the Academy of Arts and Manufactures, which Franklin frequented. He served on the boards of charitable institutions, like Guy's and Thomas's Hospitals. He remodeled the Hyde, with the aid of Sir William Chambers. His town apartments were first at Craven Street, where he was Franklin's neighbor, and then at Chesterfield Street, where he entertained Adams, and which he relinquished only in 1801, in old age, three years before he died. He was moderately well-to-do. In 1774, his friend Hollis—chiefly remembered for his donations of Whiggish books to Harvard and other libraries—left his entire estate to him, only excepting minor bequests to friends and institutions. The two had, according to Hollis's diary and a note in the will, seen rather less of each other in the late sixties, but there seems no reason to doubt that Brand was very much of his friend's way of thinking and shared his taste for coins, pictures, and virtu. Above all, he shared his deep interest in the American colonists.

It was this interest, and the desire to work more effectively on their behalf that led Brand Hollis, as he now called himself, into the greatest mistake of his life, and its most dramatic incident. In 1774, he decided to enter Parliament and, forgetting all the passionate condemnations of the elective system that his friend Hollis had so frequently voiced, attempted to use the fortune just bequeathed to him, to buy his way into the Commons. He was unusually naive; he was of the wrong political party; and some eighteen months after his return as M.P. for Hindon in Wiltshire, he was tried for "Notorious Bribery," fined one thousand marks, and sentenced to six months in jail which he served during the summer and fall of 1776. His enemies never ceased to taunt the reformer with this unfortunate episode. His biographer and heir, John Disney (1746–1816), a Unitarian minister whose acquaintance he made about this time, is careful to explain his motives, though he could not condone his mistake.[6]

Disney and Brand Hollis met in the seventies. From this time on, Hollis's life and the causes he promoted may be treated together. A good deal of material, even outside the Disney *Memoir*, privately printed and distributed in 1808, may be gathered about Brand Hollis until about 1793. Then, perhaps hampered by wartime restrictions and by age, he seems to have been less active. He was, indeed, an invalid for three years before he died in 1804. He left his family estate, and that of his friend Thomas Hollis, to John Disney, who

[5] W. R. Scott, *Francis Hutcheson* (Cambridge Univ. Press, 1900), is the best modern study of the philosopher. Hutcheson's politics, however, must still be studied in his *System of moral philosophy*, 2 v. (London and Glasgow, 1755), with a memoir prefacing volume i, by William Leechman.

[6] *Memoirs*, 11. Also, *The Trials in . . . against Richard Smith, esq. & Thomas Brand Hollis, esq.*, London, 1776.

was, like himself in 1774, quite unprepared for the bequest. He had never married.

The English sympathizers with the colonial cause have often attracted the attention of students. There has, however, been a tendency to deal with them as individuals or as members of one or another group or social class. What was obvious to contemporaries, but too often escapes the historian, is the fact that the law reformers, the new economists, the humanitarians, the parliamentary radicals, and those several associations anxious for religious liberty for Anglicans, Dissenters, and Unitarians, are not only closely interrelated, but are all in the most sympathetic communion with Americans in London and overseas. Franklin's "Honest Whigs" may be found not only in their tavern near St. Paul's, but also in the chambers of John Lee (1733–1793) in Lincoln's Inn, and among the congregation of Theophilus Lindsey at the Essex Street chapel. Each group had, of course, its own peculiar character and interests, but, as they are studied more closely, they will be found to have had a common denominator in their pro-Americanism.[7]

In 1785 Christopher Wyvill and Benjamin Franklin were both in France. They corresponded about English parliamentary reform. Franklin, as usual, offered practical advice. In thanking him, Wyvill hoped that "his benevolence has not been misplaced; since the advocates for a reformation of Parliament, have been, I believe without exception, zealous opponents of the American War." He concludes this letter by hoping for a reunion of the English-speaking countries.[8] Some years later, in the Commons, Edmund Burke, by now definitely numbered among the conservatives, opposed Charles James Fox and the plea of the Unitarians for relief from penal laws. He expressed the view that Unitarians, Jacobins, and Paine-ites were much of the same way of thinking. In his mind were associated as rebels Americans, French revolutionaries, reformers, and all kinds of dissenters. He distrusted radicals of all kinds. It is not without significance that Catherine Macauley (1731–1791), Whig historian and friend of Washington, attacked Burke as early as 1772 for his illiberality, and that she was supported by the Hollis coterie.[9]

Naturally, since Brand Hollis was of Dissenting stock, he was concerned in movements for greater religious liberty. He himself, his friend Thomas Hollis, and many of their friends were inclined towards Unitarianism. The earliest activities in which they were involved were inspired by Archdeacon Blackburne's *Confessional* (1765), itself the spiritual child of John Jones's *The Candid Disquisitions* (1749). Both treatises emphasize the uselessness of oaths. They deplore the over-definition of dogma and would much simplify creeds and professions of belief. Blackburne was to compile the *Memoirs* of Thomas Hollis. He was the friend of Priestley and the father-in-law of Disney and Lindsey. In 1771, a petition for the relaxation of rules relating to subscription to the Thirty-nine Articles required of university students and at all stages in promotion in the ecclesiastical heirarchy, was drawn up at the Feather Tavern, on lines laid down in Blackburne's book. In Parliament, William Meredith (d. 1790), Sir George Savile, Alderman Sawbridge (1732–1795), friend of Wilkes and brother of Mrs. Macauley, and some of the Chatham connection supported it. Burke opposed any change in the Established Church, and the petition failed to pass. The failure to modify subscription led to withdrawal from the Church of Lindsey and Disney, though the Archdeacon remained within it. Lindsey then established, though without legal sanction of any kind, the Essex Street chapel, the first openly Unitarian communion in England. Brand Hollis, from the first, attended it, and most of his friends, English and American at one time or another took part in its services. John Jebb (1736–1786), leaving Cambridge University about this time, and, for reasons similar to Lindsey's, now lived in London and devoted himself to medicine and to reform. Brand Hollis had known him since 1767 and, indeed, owed his friendship with Disney to him. John Lee, associated

[7] Carl B. Cone, *Torchbearer of freedom*, Lexington, Univ. of Kentucky Press, 1952, a study of Price's life and influence, contains in chapter vi the best modern account of the "Honest Whigs." On Lee's chambers as a rendezvous for reformers, see H. McLachlan, ed., *The letters of Theophilus Lindsey* (hereafter Lindsey's letters), *passim*, Manchester Univ. Press, 1920; and J. Priestley, *Memoirs to 1795*, 88, London, 1806, where affectionate references to Franklin, to Lindsey, and to Lee may be found; e.g., Mr. Lee "who amidst the bustle of politics, always preserved his attachment to theology, and the cause of truth."

[8] *Political Papers*, collected by Rev. C. Wyvill, York, **3**: 363–369, 17 June 1785 (hereafter to be cited as Wyvill), W. Blanchard *ca.* 1804.

[9] For bitterness towards Burke, see article by the present writer, *William and Mary Quart.* 3rd ser., **7** (3): 406–453, 1950, and references in it to the Hollis circle. For attempts in Parliament, see W. Cobbett, ed., *Parl. hist. to 1803* **17**: 245 ff., 1813; Feathers Petition: *ibid.* **28**: 1–41, 1816; Dissenters: **29**: 1373–1403, 1817; Unitarians, Burke's speech, 1382 ff.

with the defense of Wilkes in the sixties, and the intimate of Priestley and Lindsey, helped the latter with his legal problems. The Duke of Grafton (1735–1811), Charles Lennox, Earl of Richmond (1735–1806), Samuel Shore of Lincoln's Inn, and Michael Dodson (1732–1799), lawyer and writer, Gilbert Wakefield (1756–1801), as well as Franklin and Adams, when in London, swelled the Essex Street congregation. No one, indeed, can study eighteenth-century political and religious history for long without realizing the importance of this body in the radical movement of the Age of George the Third.[10]

The Unitarians were in fact unmolested, although unsuccessful in obtaining any recognition of their right to worship. Equally unsuccessful, though persistent, were the attempts of the older sects, Presbyterians, Baptists, and Independents, to induce eighteenth-century governments to relax the rules of the Test and Corporation Acts which kept conscientious Dissenters from political office. Parliamentary motions were made in 1772–1774, 1779, 1787, and 1789, all of these supported by the left wing Whigs and opposed by the Burke faction. Brand Hollis himself wrote a short tract on the repeal of the penal laws in 1787, and a copy inscribed by him to Mrs. Adams is in the collection of the Massachusetts Historical Society.[11]

For three-quarters of the eighteenth century public opinion prevented any amelioration of the laws which made life difficult for Roman Catholics. Thomas Hollis of Lincoln's Inn had feared popery [12] and any leniency towards it. But Priestley argued with him for real tolerance, and, by the mid-seventies, Blackburne and Brand Hollis endorsed liberty for all shades of religious belief. Not everyone shared their views. In 1778 Saville and others managed to win a measure of relief for Catholics in Parliament, and it is to the credit of the Government that the law was maintained even in the face of the Gordon riots and some popular hostility to this Act. Much, however, remained to be learned before any real emancipation could be hoped for by Catholics or Dissenters alike.

The Brand Hollis circle was intensely interested in the whole subject of education and was concerned in the attempt by Jebb to reform the University of Cambridge. This project concentrated on a system of public examinations. It failed and Jebb himself left Cambridge for a variety of reasons. Amongst his students, however, Capel Lofft and John Baynes absorbed his liberal ideas and assisted his campaigns in London. Baynes (1757–1787), it may be remembered, brought the emancipator Wilberforce before his constituents at Hull and left his law library to Romilly. Price and Burgh taught at Newington; Hollis had been taught by Hutcheson. It is not surprising, therefore, to find most of these men interested in the foundation of an academy at Hackney. This, of course, catered to men of university age and especially to those expecting to enter the ministry. Here Priestley taught, as well as Price and Kippis. John Disney in the *Memoir* suggests that, in spite of the liberality of his friend and others, the "very respectable" coadjutors' poor management brought about its end in 1796. In this, the Academy resembled its benefactor, Brand Hollis, "whose radical aversion to business of any kind," concluded Disney, "was so great as almost to disqualify him for attenting to . . . the minutiae of his private concerns."

Disney was, in this, excusing the "unfortunate election" at Hindon, which, however, did not deter Brand Hollis from promoting "the cause of reformation in the British House of Commons" throughout his life. The corruption of Parliament, as well as the inequalities and illogicalities of its representative character, had long been a byword. Failure to pass any measure of relief for Dissenters added to dissatisfaction. This was fanned by the attacks of William Pitt, later Lord Chatham, on the system of party or faction under Walpole and his heirs, and by the controversies over Wilkes. The Stamp Act disputes further embittered feelings of the Hollis circle about the Commons. Shorter Parliaments, less vulnerable to corrupt influences, had been advocated in mid-century. Some Scots, like the author of *Liberty and Right*, proposed really drastic changes in 1747, and were admired by the reformers. Richard Baron (Brand Hollis's classmate, later a protégé and collaborator of Thomas Hollis) advocated what he called a "reform by counties"—an extension of the shire against the

[10] N. Sykes, *Church and state in the eighteenth century*, Cambridge at the Univ. Press, 1934, best general account of the whole topic. See also, *Lindsey's letters* & J. Priestley, *Letters*, ed., J. Rutt, London, 1831–2, for a valuable insight into Unitarian activities of the time. No attempt is made here to differentiate between Arianism as of Price and Unitarianism generally.

[11] *Address to the Opposers of the Repeal of the Corporation and Test Acts* (by Thomas Brand Hollis), 40 pp., London, 1790.

[12] *Memoirs of Thomas Hollis of Lincoln's Inn*, compiled by F. Blackburne, London, 1780; *passim* for anti-Popery sentiment, and *William and Mary Quart.* article referred to above, p. 447, n. 130.

borough representation. This was advertised by Hollis, and endorsed by Chatham. Glynn, Lee, and Adair started a Society for the Bill of Rights in 1769, which included many pro-Wilkesites and radicals. Much the same group in the seventies, with Jebb and Cartwright, author, it will be remembered, of the pro-American *Take your Choice* (1776), Wyvill and Lofft, as leading spirits, planned, talked and wrote on the subject of Parliament. Unhappiness over the American war deepened their interest. In 1780 a Society for Constitutional Information was formed to disseminate radical ideas. Associations for reform sprang up. In Essex, Brand Hollis played a leading role, as he did, indeed, in the Westminster constituency, one of the few urban centers where the franchise was wide. All hopes at first were centered on the younger Pitt, trained by a father whose devotion to liberty had been doubted, only very briefly, at the time of his elevation to the peerage, and whose teaching was known to have been of the "real" or libertarian Whig tradition. Pitt, however, disappointed them long before the reaction engendered by the French Revolution set in. The reformers continued their petitions, meetings, and publications of the works of Sidney, Locke, and other heroes, although dispirited by ill success. Brand Hollis, himself, presented at a Westminster meeting the most drastic of early programs advocating equal electoral districts, manhood suffrage, the ballot, and annual Parliaments, four points not to be realized for many years to come, though he continued to hope for them.[13]

The same group celebrated the Glorious Revolution in the November of 1788, and acclaimed the French Revolution of the following year. Indeed, their enthusiastic endorsement of the latter drew not only Burke's strictures, but failed to find any echo in the hearts of many of their American friends. Yet for their generation the French Revolution marks the end of a great tradition and the beginning of a new egalitarianism. This is true on both sides of the Atlantic. Jebb died in 1786, Price in 1793, Priestley, in America, in 1804, and Brand Hollis in London in the same year. Some, like Lofft and Cartwright, Jefferson and Adams, lived until the eighteen twenties, but with the death of these last two the line of the classical English republicans may be said to be ended. Their influence lived on in the American constitution, and, in the western world, in many political rights, but, in the history of the radicals of the nineteenth century, the French Revolution marks the beginning of a new ideology and a break with the *ancien régime*, as well as with the revolutionary politics of the past in England and France.

Brand Hollis's American connection was due to his own early associations and to his later activities and friendships. On receipt of his friend Thomas Hollis's bequest, he at once started correspondence with the Harvard authorities, with Andrew Eliot and other New Englanders, which concerned both the legacies to them and public affairs. He continued his friend's gifts of appropriate books to Harvard, and, if his many gifts to the New York Society Library are any indication, extended the area of such benefactions. His friends, Lindsey, Price, and Timothy Hollis (Thomas's cousin), met and read aloud letters from America. They dined Josiah Quincy before his departure. They greeted with enthusiasm news of Colonel Barre's speech in the Commons for the American cause. Cartwright, Paine, and Price had published tracts in the same vein. Lindsey, in his letters, cheers the prospects that Americans will baffle all English attacks in 1776.[14] Brand Hollis, in January 1775, wrote to Simeon Howard a long letter which reflects the sentiments of the honest Whigs. "Those who think in this country," he writes, "are much concerned with the unhappy state of America and dread the consequences to both countries" of any break. He deplores the principles of Hume and Bolingbroke and thinks the Scotch historian has spread despotism and undermined the principles of the constitution. Better things are to be hoped from American resolution and firmness in the maintenance of "just rights and liberties" against the "unjust Boston bill and the detestable Quebec Act." A comparison between Ireland and America is dreaded. "Parliament has no right to tax Ireland, nor do they claim it." Can anything be more absurd than that a country can be taxed at a distance? As Locke wrote, "What property can I have in that which another may take from me at his pleasure?" [15]

[13] William Harris, *History of the Radical Party*, 30–32, London, 1885, describes the radical plan Hollis brought forward at Westminster. Wyville, 1: 228, 240–243, and throughout, contains much on Brand Hollis's activities. See also, J. Disney, ed., *Works of J. Jebb*, with a *Memoir*, London, 1787, which contains further Brand Hollis material.

[14] *Lindsey's Letters*, 76, 78, 81.

[15] Willard letters, as before, throughout. The letter to Simeon Howard is in the Boston Public Library MSS Collections, Ch. a., I, 63, and dated 4 Jan. 1775.

Josiah Quincy was an habitué of the "Honest Whigs" during his London visit and was dined, as already stated, by the Hollis circle as he left. Brand Hollis, himself, gave him a present of books to read on ship. Affectionate letters survive from Brand Hollis and his friends to Quincy on the eve of his departure, though few details as to the extent of their acquaintance survive.

Even scantier are facts about Hollis's acquaintance with Franklin. It seems likely, in view of his intimacy with their mutual friend Richard Price, that that good man introduced them to each other. But, though there is no direct evidence of Brand Hollis's attendance at the "Honest Whigs" (as already noticed, he and Franklin were neighbors on Craven Street), he at least knew most of the members of that club and may occasionally have joined them. Thomas Hollis had avoided Franklin, indeed suspected him as a "trimmer." None the less Franklin was sent a copy of Blackburne's *Memoir of Thomas Hollis*, whilst he was in Paris, and thanked Brand Hollis warmly for it, noting the many ideas and projects he had had in common with that eccentric republican. This letter has long been available in print, but Brand Hollis's reply has not, and as an expression of whole-hearted admiration by an Englishman is well worth reading.[16]

Sir

The loss of a young person of fine dispositions and excellent principles in whose education I greatly interested myself, as intending him to be my son & heir, has prevented me attending to matters which at another time would have engaged my thoughts; was it not for this, I should justly incur the imputation of negligence as it is some time since I received from you a medal to commemorate the glorious events of the Independency of America & the total subjugation of their enemies events which I rejoice at as I have always detested and abhorred the principle of enslaving mankind and depriving them of the rights of human nature, under any pretence whatsoever.

The medal I esteem on all accounts as a great honor from the donor, it is a most valuable addition to my friends collection of Liberty coins as he used to call his cabinet. The head of your Liberty would have pleased him, it is simple & noble the execution is good but I could have wished the names & dates of your victories had been wrote in capitals & also the date of your independence that every part might be intelligible.

There is a mistake in the word *Juil* which might yet be altered. Indeed Sir, the three noble subjects united in your medal claim each a distinct medal and had I the honor to be an American it should be done; for never in the Annals of mankind such events have had such glorious consequences. The divine rights of human nature are declared & established against all the Arts of Priests & Tyrants & there is now an Asylum for the injured & oppressed.

I hope the coinage of America will be attended to at proper time. To be decimal on account change as the present roman coin is and the copper currency to perpetuate Historical events as mentioned by Addison in the Spectator which might be done with small expence. To me it is matter of surprise, after having considered it & which I cannot sufficiently understand how the Romans struck their medals, as it is known they were often struck in the camp and of emperors who lived but three days and perhaps there are not two of the same Dye of any one Emperor. I rejoice you estem my friends labors for the Publick. There never was a man who having the means indulged less & spent his whole time in publick services. Candor to the publick obliged the compilers of the Memoirs not to conceal any sentiment of my late friend's. His anxiety for the publick weal made him suspicious of Characters eminently great but which by their strenuous exertions have demonstrated to the world how much they are superior to detraction.

The mistake about your letter attributed to Mr. Adams shall be rectified in a future Edition.

The first opportunity I will convey to you Milton's tractate on education which I could not induce the Booksellers, tho at my expence, to print with Johnson's poets as it always accompanied his Poeticks. The Cowleys Proposition is published with his Poems —such is the fear of Johnson with the Booksellers who unwillingly sell the remarks on Milton's Life.

May you like Timoleon, long enjoy the glorious satisfaction of having emancipated your country and established freedom on the broad basis of equal Laws, and believe me to be with the greatest esteem and respect for your worth & excellence

Sir

your much obliged
humble servant
T BRAND HOLLIS

Bruton Street
June 21, 1784. same

It was three years before Brand Hollis sent the *Memoirs* to Thomas Jefferson in Paris and received a warm acknowledgment.

In 1785 Brand Hollis sent Franklin, on the eve of his return to America, Blackburne's *Remarks on Milton*, and accompanied this with a further criti-

[16] A. H. Smyth, ed., *Writings of B. Franklin* **9**: 103–105, N. Y., Macmillan: *Memoirs of Thomas Hollis* **1**: 335–336, and see 333. E. Millicent Sowerby, ed., *Catalogue of the library of Thomas Jefferson* **1**: 166, Washington, Lib. of Congress, 1952, notes a similar exchange.

cism of the policy of the government of George III.[17]

A Monsieur Franklin Ministre des Etats Uni D'Amerique a Paris

Dear Sir

Having an opportunity of sending by a private hand I request the favor of you to accept of the Remarks on Johnson's life of Milton with the Aereopagitica & the tractate of *Education*. Thomsons preface is here preserved which was omitted in Murdochs Edition of Thomsons works tho published by subscription for a monument! The genuine spirit of the court discovers itself in the abuse the New Poet Laureat bestows on Miltons prose writings & insinuates not obscurely what we may expect from future ministers; the utmost exertions of regal prerogative or in other words of Despotism & as a friend likewise adds all our modern ministers & great men seem to play with the people very much at their ease & will continue so to do till the people are roused to vindicate themselves. not so in America the Americans have vindicated themselves thanks to heaven & your exertions. May ease & happiness attend you in your return to your native soil & the congratulations of a grateful people tranquilize your age & increase your satisfactions is my earnest wish & desire.

I am Dear Sir
with the greatest regard
& esteem
your obliged humble servt
T BRAND HOLLIS

Bruton Street
June 28. 1785

The tone of the Franklin letter is perhaps not that of an intimate, but it is certainly that of acquaintance.

With Adams as with Quincy, at different periods Brand Hollis was on more intimate terms. Essentially it was the same group, intimate with Quincy and friendly with Franklin—Brand Hollis, Kippis, Price, and Bridgen—that welcomed Adams when he came to London. If Jefferson and Adams had not met Brand Hollis's dinner guests in 1786, they certainly knew all of them by reputation already. Adams slipped into intimacy with his host, with Price, with Jebb's charming widow, with good Dr. Thomas Wren (*fl.* 1757–1787) of Portsmouth, who had helped American prisoners during the war. He consorted with the London printers and booksellers, Almon, Cadel, the Dillys, and Strahan, who had published so much pro-American propaganda during the seventies. He met nearly all the Essex Street group and those divines who were associated in the Hackney experiment. Adams's London circle seems to have been a little less concerned with sciences and arts than Franklin's, and more with politics and history, but his diary is brief, and it is dangerous to deduce too much from the letters of that period which survive. What does seem quite certain, attested by Disney's *Memoirs* and the Adams letters and memoranda, is the fact that Adams's chief English friends were Richard Price and Brand Hollis. This fact alone should ensure the latter a measure of immortality.

The letters show not only this intimacy, but also suggest the degree of difference in politics that friendship survived. That difference is also illustrated by Brand Hollis's letters in the Willard Correspondence.

Brand Hollis and Price, like Tom Paine, welcomed the French Revolution and were more than hopeful of its outcome, perhaps because of the frustration of their own political projects at home. Adams agrees with Hollis, who had evidently written on the new constitution in 1788, about the importance of juries and of untrammeled public opinion. They evidently shared an interest in Zeno and the "Balance" so frequently advocated by the American. But Adams cannot share his friend's enthusiasm for the developments in France. The tone of these letters is always affectionate and personal. Once Adams suggested emigration, and, jestingly, even marriage, for Brand Hollis, though the Englishman was then over seventy.[18]

About Brand Hollis's intimacy with Tom Paine little is known. Chalmers's statement about his share with Holcroft and Godwin in the *Rights of Man* has been amply refuted, but is certainly evidence of the radical reputation he bore. If his

[17] The letters to Franklin are in the collections of the American Philosophical Society, to which I am much indebted for photostatic copies. I cannot identify the young man referred to. The silver medal was sold at Sotheby's in 1817 at the sale of the Hollis, Brand Hollis, and Disney collections. All three were enthusiastic about numismatics. The *Remarks on Milton*, referred to, were issued both separately and as an appendix to the *Memoirs of Thomas Hollis of Lincoln's Inn*. Blackburne defends the republican Milton from criticism.

[18] The *Diary of Adams* in the *Works* cited above, **3**, the Willard letters, and the Disney *Memoirs*, with its appended material, form my authority for the Adams connection. Brand Hollis was a well enough known eighteenth century character to be sought as a signatory in the Dreer collection, now in the Pennsylvania Historical Society Collections.

The Massachusetts Historical Society Collection of miscellaneous manuscripts (Hollis volume) contains letters from Hollis and others to Quincy.

views were sufficiently similar to Paine's to make the attribution credible at all, Brand Hollis was certainly much more republican and revolutionary than Adams, who was at this time increasingly critical of the author of *Common Sense* and the adopted citizen of both America and France. On the other hand, the benefactions of Brand Hollis were extended to any that seemed to be friendly towards his many good causes, whether he knew them well or not. He helped Priestley after the mob attacked his library in Birmingham. He befriended Wakefield. He gave money to Alexander Geddes (1737–1802), scholar and translator of the Bible, who fell on evil days in 1801. The association with Paine seems more intimate than with the last two, but is tantalizingly undocumented.

Brand Hollis was in the thick of the fight for freedom. Any form of oppression excited his indignation. His support of the Americans never faltered. His expressions of faith in the future of the New World were explicit and frequent. That he foresaw the difficulties of democracy as they developed in the ensuing centuries is unlikely, but that he interpreted and extended in his own time the libertarian traditions of the republicans of an earlier period cannot be doubted. He was one of a small but significant band of radicals who redeem the barren wastes of the political scene of his time. Burke's philosophy is a precious heritage, but his record in practical politics not so clear-cut, and is less likely to win our admiration today. Without the persistence of the Brand Hollis circle, the influence of Burke might have been wholly reactionary. In the history of liberal ideas Price, Priestley, Jebb, and Brand Hollis have an important place. They had the courage to maintain faith in the Whig tradition of resistance to despotism, when the policies of their contemporaries and countrymen ran counter to it during both the American and the French Revolutions. Security and equality were to be the demands of the future, but without the continuing demand for liberty, these might not create or satisfy free peoples.

On 4 November 1788, Brand Hollis was a steward of the meeting of the friends of the "constitutional liberties of England." A great number of respectable persons, his biographer informs us, formed a Revolution society, and made the following the bond of their association:

> That all civil and political authority is derived from the People.
> That the abuse of power justifies resistance
> That the right of private judgment, liberty of conscience, trial by jury, the freedom of the press and the freedom of election ought ever to be held sacred and inviolable [19]

To these principles Brand Hollis and his band remained faithful throughout their lives. This devotion, which they shared with their American friends, has continued to maintain, during many trying times, an Atlantic community of political interest.

[19] *Memoirs*, 16.

# EXCAVATIONS AT MYCENAE 1952

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(*Read November 13, 1952*)

THE British excavations at Mycenae in 1952 were conducted with a research grant from the American Philosophical Society assisted by contributions from the Universities of Cambridge and Oxford, the British Academy, the Leverhulme Trustees, and the British School at Athens under whose aegis the work was carried out.

The principal objectives of the campaign were the following: the making of a new survey of the area on the top of the ridge running westwards from the Lion Gate; further investigation of the Prehistoric Cemetery discovered outside the Lion Gate to the west in 1939 and 1950; thorough re-examination of the ruins by the side of the modern carriage road once tentatively called a Hellenistic Gymnasium; the clearing of the House of the Oil Merchant (found in 1950 and formerly called the House of Stirrup Jars) and of the House of the Wine Merchant (found in 1951 and part of the Cyclopean Terrace Building).

Of the post-Mycenaean monuments the most important yet discovered is the Perseia Fountain House, once tentatively called a Hellenistic Gymnasium, but now definitely identified in the excavations of 1952. This fountain house was seen by Pausanias in the second century A.D. among the ruins of Mycenae. Although the existing ruins are of Hellenistic date there are indications that a fountain house or some other provision for a water supply had previously existed in this area. The water was presumably led to this site in a channel from the well-known spring called by the modern inhabitants *Neromana*, but by archaeologists Perseia which rises about twenty minutes to the east of the citadel. Traces of a water channel can still be seen just below the northwest angle of the Cyclopean walls. Along the north side of the top of the ridge runs a well-built terrace wall which rests on one edge of a stone water channel. Before the terrace wall a flight of steps was built which seems to have led down to some kind of water basin which was probably in connection with the stone channel. Near here too Tsountas found the early fifth century inscription (*Inscriptiones Graecae* IV, 493) which refers to Perseus and seems to have formed part of some kind of water installation.

The terrace wall is probably of Hellenistic date, third century B.C., and presumably belongs to a reconstruction of this water supply when Mycenae was reoccupied at that time. Before the terrace wall two basins were built. On the east there is a wide basin which had in front of it a paved court which seems to have been roofed over. This was no doubt to protect the women and girls who came to draw water. The pavement shows signs of having been reconstructed. To the west there is another similar basin. It is, however, narrower, has a lower parapet, and is divided across the middle by a marble slab which is a boundary stone from a shrine of Hera of the fifth century reused for this purpose. When the basins were built the line of the water channel, which originally ran down by the side of the steps, was changed so that the water entered the eastern basin from the east and then passed through a communicating hole into the western basin. From the western basin the water ran out into the stone channel. The western basin is somewhat shallower than the eastern and if the eastern basin was intended for human beings the western may have been intended for watering animals.

The identification of this Perseia Fountain House following on the identification of the new Grave Circle found by the Greek Achaeological Society as the traditional site of the graves of Clytemnestra and Aegisthus now enables us to say that all the monuments of Mycenae mentioned by Pausanias have been identified except one, the Tomb of Atreus. The search for that must remain one of the objectives for future work at Mycenae.

South of the Perseia Fountain House and midway between the tholos tombs known as "The Tomb of Aegisthus" and "The Tomb of Clytemnestra" we found a well-built wall faced with poros blocks carefully cut and laid. This wall runs up the slope of the ridge from south to north and at its northern end seems almost to join the southernmost point of the curved wall which runs southward from the western end of the main terrace

wall of the Perseia Fountain House. It does not actually join, however, and the two walls seem to be separate because another wall runs off eastwards at right angles to the poros wall at its northernmost end. This wall is differently built. It is made of small stones packed together with the usual yellowish clay which was used as mortar by the Mycenaeans and comes either from Longaki or Plesia. This cross wall was found at the close of the excavations and there was not enough time to examine it properly. That will have to be done another season. The poros wall is built of small stones packed with yellow clay and is about 1.20 to 1.30 m. thick. It is faced on the east with four courses of poros blocks which vary slightly in height from 0.35 to 0.40 m. They vary also in width, but their depth is on an average approximately equal to their height. They rest on a foundation of small stones roughly coursed which in height equals about one row of the poros blocks. The total height of the wall is about two meters. At the level of the base of the lowest course of poros blocks there is a layer of whitish yellow clay which seems to have extended along the face of the wall at this level and also for some distance in front of it. This was presumably the ground level at which the wall was built. The wall runs for about twenty meters as far as it has been possible to trace it at present and is built on a slope as it runs up the hill. The poros blocks especially where they are preserved at the north end incline outwards, but this may be merely accidental owing to pressure from behind. At the northern end only the small stone foundation is preserved, but several displaced poros blocks were found lying in front of the wall. Either stone robbers had plundered the wall for building stone or else, since the top of the wall at this point was not more than 0.20 m. below the surface, the blocks have been displaced in the course of ploughing. Against the southern part of the wall and by the third row of blocks from the top lay a human skeleton stretched at full length with the head to the south. Since no funeral offerings seem to have been buried with it, this was probably a late burial and has no connection with the wall.

When the wall was first found it was not unnaturally thought to be one side wall of the dromos of a tholos tomb. Trials further east to attempt to find a parallel wall have so far proved fruitless. Thus the purpose of this wall is still unexplained and further excavation must be undertaken in this area to define its object and date. Since it is well built and of carefully cut poros it most resembles the dromos walls of some of the tholos tombs of the Second Group which is assigned to the fifteenth century B.C., L.H.II.[1] To the east of the wall at varying depths, but still all above the level of the lowest row of poros blocks many vases were found. Several of these, for instance a fine askos and two mugs, are of undecorated or partially decorated fine, pale, yellow buff ware and resemble vases found in Room 4 of the House of the Oil Merchant which are dated by their context to L.H.III B. Outstanding vases found in this same region are a fine stirrup jar, a large stirrup jar with a painted inscription in the Linear B script, and a fragment of another, and a large fragment of a chariot vase of undoubted Mycenaean fabric of the powdery surfaced and not of the harder well-polished variety. The stirrup jars are probably L.H.III B, but the chariot vase might be even earlier. It is of excellent style notably in the drawing of the horse's legs and in the absence of filling ornaments. The painting is executed in red picked out with white all drawn on pale buff slip. In all about seventy vases were found in this area. At the north end of the area just to the south of the modern aqueduct and north of the east-west cross wall we found about 0.20 m. below the surface a hoard of bronzes. These all lay in one heap as if they had been carried in a canvas bag which had perished long ago. The bronzes include a large double axe of the normal type, a small hammer which shows signs of considerable use, two chisels, a drill (?), an adze, several curved knives, the handle of a large cauldron, a dagger with a horned handle and a raised midrib engraved with lines. The group which was probably the stock in trade of a bronze worker also contained many pieces of sheet bronze, a lump of metal which appears to have been melted in a crucible, and a number of pieces from ingots of the usual hide shape. These last were weighed, but their weights do not seem to suggest any system. These pieces

[1] The successive periods of the Bronze Age on the Greek Mainland are called Early, Middle, and Late Helladic. The Late Helladic period is sub-divided into three phases known as Late Helladic I, II, and III. The latest phase in turn is also sub-divided into three stages known as A, B, and C. These various periods are for convenience abbreviated by archaeologists as E.H., M.H., and L.H.I, L.H.II, and L.H.III A, L.H.III B, and L.H.III C. The absolute dating of these periods is apt to fluctuate, but they may be dated approximately, L.H.I 1580–1500 B.C., L.H.II 1500–1420 B.C., L.H.III A 1420–1340 B.C., L.H.III B 1340–1210 B.C., L.H.III C 1210–1110 B.C.

therefore must be assumed to be casual fragments of ingots.

In this same area a large deposit of much broken pottery, mostly of the L.H.III B date, was found well mixed with broken terracotta figurines. Among the figurines there is one of some interest, since it represents a man riding a horse. There has been much discussion about riding and driving in Mycenaean and Homeric times. Some have asserted that the Homeric heroes never rode horses, but only drove them and the same assertion has been made about the Mycenaeans. The finding of this figurine, however, shows clearly that the Mycenaeans did ride horses. In war presumably they used horses in chariots only, but made no use of cavalry. In ordinary life, however, riding seems to have been practised as is natural. Homer's heroes do occasionally ride, but not when they are going out to fight.

Further excavation of the part of the Prehistoric Cemetery lying to the west and northwest of the area excavated in 1939 was undertaken in the hope of finding more graves. Several more Middle Helladic graves were in fact found, and they were numbered No's. XXV to XXXIV. Number XXV was an unenclosed grave of a young adult. The skeleton lay on its left side in the usual contracted attitude with the head to the west. In front of the face was a small spouted stone vase of serpentine.

Grave XXVIII was an unusual grave. It was in a shallow, circular, rock cut pit about 0.50 m. in diameter and 0.45 m. deep which was lined with stones and covered with a round slab of stone about 0.43 m. in diameter. Inside this was packed the skeleton of a child with which were three small beads, one of bone, and two of glass.

More important than all these were the remains of the contents of what must have been a rich L.H.II tomb. Just north of the shallow pit found in 1939 (to the west of Grave X) we came upon a group of remarkable ivories. These include four pieces carved in the round which resemble model figure-of-eight shields. They are about 0.18 m. long and about 0.03 m. thick. Whether these were really intended as models of figure-of-eight shields is uncertain because they have no backs. With them was another yet larger object about 0.27 m. long, 0.10 m. wide and 0.05 m. thick in solid ivory which must have been cut from an exceptional tusk. This has at the bottom a tenon for insertion in a socket. Above this are two circles like a figure-of-eight shield and the whole is surmounted by a disc which is pierced with a triangular hole. The object thus resembles a caduceus and may have been a sceptre or a herald's staff. All these five objects were probably originally covered with gold leaf for in the earth all around them was scattered a great amount of thin gold leaf. It is to be hoped that further study and comparison with other ivories from Mycenaean sites will help to elucidate their purpose. Another suggestion is that they may have been part of some piece of furniture, a bed or a chair.

In the same place two magnificent ivory plaques came to light. The larger one is about 0.25 m. long and 0.075 m. high. The smaller one is about 0.125 m. long, and 0.04 m. high. They are both complete on their edges and the larger one shows the curve of the tusk from which it was cut. They fit together and must have formed part of a large composition made of such plaques and fastened, like these, by ivory pegs to a backing which was probably of wood. The composition which must have been at least half a meter long and probably about 0.15 m. high showed two standing griffins confronting one another. The large plaque shows the greater part of the right hand griffin from the knees to the neck with the lower part of the wings. The hind feet were on a separate plaque which is lost and the eagle-like head would also have been on a separate plaque now lost. The smaller plaque which fits closely to the larger one shows the front feet, two of the right hand griffin and one of the left hand griffin which is otherwise entirely lost. There is a moulded border at the bottom. The griffin is carved in low relief with great sureness and delicacy. The drawing of the muscles of the body and legs is masterly and would be called lifelike if griffins were not mythical. The attitude of the creature is dignified and we can rightly consider this a Mycenaean masterpiece. At the base of the wings can be seen the spirals which are usually in this position on Mycenaean griffins. Comparison of this with the griffins of the fine pyxis from the Agora shows a great difference in style and execution. Behind the right hand griffin there is a moulded border and part of an uncertain subject, perhaps a bird preening its wings with its beak. Though much thin gold leaf was scattered freely in the earth all about these plaques we cannot tell whether they were once so gilded. Probably they were not. The figure-of-eight shields have no carved surfaces and so could be gilded, but these plaques are delicately carved so that the addition of thin gold leaf to the surface would have obscured much of the finer detail. In the area round these ivories were many pieces of Palace

Style amphorae and several pieces of Ephyraean cups. Such vases are characteristic of L.H.II and so we can perhaps date the plundered tomb from which these ivories came to L.H.II, the fifteenth century B.C. Where the tomb was we cannot yet tell but it might have been the pit mentioned which was found empty in 1939 just to the west of Tomb X.

The House of the Oil Merchant was discovered in 1950 and a brief account of its discovery and the first finds made in it has already appeared. In 1952 practically the whole of the basement of the house was cleared and efforts were made to try to define its extent. The house was originally called The House of Stirrup Jars, but, since it now seems that most Mycenaean houses had a storeroom with large stirrup jars, it is better to give it the more distinctive name of "The House of the Oil Merchant." The house lies to the south of the tholos tomb called "Tomb of Clytemnestra" and close to the east side of the modern carriage road. It is built on terraces on the sloping hillside. On the east the house is supported by a long wall, two to three meters high, built of rough blocks of limestone in the Cyclopean manner. About the middle of its length the Cyclopean terrace wall has a set back, but this as yet does not seem to have any definite purpose. At its northern end the Cyclopean terrace wall has a clear angle and returns westwards. North of this is the angle of another Cyclopean terrace wall which also returns westwards, leaving a narrow lane about three meters wide. This northern terrace wall seems also to be the supporting wall of a large private house similar in type to the House of the Oil Merchant. A trial in it revealed below the surface humus the burnt débris of a house which had been destroyed by a violent fire. During the trial two fragments of large wellcut stone bowls in serpentine were found. Here too was found half of a model figure-of-eight shield in ivory in excellent condition. On the front of the ivory are three groups of three holes each for inlaying gold or some other precious material. At the back are cuttings for attachment to a flat surface. This may have served as a handle. Thus when this house can be excavated, there is every hope that it will prove as fruitful as the House of the Oil Merchant.

The part of the house best preserved and that so far excavated is the basement which is supported by this Cyclopean terrace wall mentioned and is bounded on the west by another terrace wall. This latter wall upheld part of the main floor of the house on a higher terrace to the west which would have been on the same level as the story above the basement. This main floor was three meters higher than the floor of the basement. The basement consists of one long corridor which runs along the face of the western terrace wall. Off it a number of rooms branch out to the east which are numbered from the north 1, 2, 3, 4, 5, etc.

In Room 1 which was entirely cleared this year was an elaborate installation of eleven large pithoi ranged round the walls. They had small bases and wide bodies and so had to be supported on either side by low walls of clay. Underneath one pithos (the second from the east against the south wall) there was provision for heating. It is said that in Tuscany provision for heating is always provided in oil stores to prevent the oil from congealing in cold weather. The pithoi have small bases which were set in collars of clay and were presumably about the same height 1.70 m. as the pithoi in the House of the Wine Merchant. In the center of Room 1 were found the fragments of a tall, undecorated jar of good shape. The walls and floor of Room 1 like the walls and floors of the main corridor and the other rooms were covered with clay plaster well mixed with chaff. In the center of the floor there is an oval sump presumably intended to catch any overflow from the pithoi. There is also a low raised and rounded line of plaster about 0.10 m. high running from the west end of the south wall across the door from the corridor. The object of this presumably was to prevent oil from running out into the corridor. The low walls which upheld the pithoi are built of clay and covered with a layer of plaster similar to that on the floors and walls.

At the north end of the main corridor were found in 1950 thirty large stirrup jars most of which had been stoppered with clay and had their stoppers sealed. In the spout of the stirrup jar was placed a stopper in shape much like a champagne cork which was fastened in with string. The string could serve either to secure the stopper or to provide an easy means of extracting it. Over the stopper and spout was then placed a cap of clay which was sealed several times with a signet. This sealing would serve a double purpose. It would prevent any tampering with the contents and also serve to identify the brand or the owner of the oil. It seems certain that the stirrup jars contained oil, for the clay of many of them shows clearly that it is heavily impregnated with oil.

The stirrup jars had been exposed to an intense heat for many of them had been distorted by it and some fragments were in addition partly fused and vitrified. Apparently they had been deliberately broken. Some had been smashed. Others had had their spouts knocked off and others seem to have been unstoppered. The object of this destruction was no doubt to spill the oil and add fuel for the flames when the house was fired.

In Room 1 in the northeastern corner behind a pithos was found a clay tablet inscribed in the Linear B Mino-Mycenaean script. It was broken in three pieces and seemed almost like an old piece of paper torn up and thrown away in a corner. In Room 2 in the debris in the southeastern corner were thirty-seven more inscribed tablets or fragments of tablets. They lay scattered among the debris and apparently had fallen from the upper floor on the collapse of the house when it was burnt.

The tablets are all written in the script known as the Linear B Mino-Mycenaean script which was the characteristic script of the Mainland of Greece and is well known from the tablets found by Professor Blegen at Pylos and by Evans at Knossos. The Mycenae tablets are apparently accounts or inventories recording dealings in some liquid commodity which may well have been oil. These are the first tablets to have been found at Mycenae (except for a surface find in 1950) and the first to have been found in Greece or Crete in a purely private house. This fact coupled with the existence of inscriptions in the same script on vases shows that the Mycenaeans were more literate than is usually supposed. Much study is now being devoted to these tablets and it is believed that the language when deciphered will prove to be Greek for the Mycenaeans were probably Greeks and so would naturally have spoken and written Greek. One tablet has an unusual feature, for on its back is a lively sketch of a man. The anatomy of the figure is so good that this cannot be a casual scribble. Since we know that the Mycenaeans decorated the walls of their houses and palaces with gaily painted frescoes, it is possible that sketches like this should be considered as preliminary studies for frescoes or perhaps vase paintings. The tablets are now being edited and will be submitted for publication in the *Proceedings* of the Society. They form one of the most important discoveries ever made at Mycenae.

Room 3 is a passage that turns at right angles southward to Room 4 which has no direct connection with the corridor. It is not easy to understand the reason for this arrangement unless the plan of the rooms on the upper floor demanded it. Room 4 was full of vases. In the southwest and northwest corners stood two large storage jars now cracked to pieces from the fire. About the room lay many other vases all cracked and broken from the fire. They included two painted stirrup vases of L.H.III B style and two fine spouted bowls of superb fabric painted with simple lines inside and out. There are also six ladles decorated with much restraint, for they have only a pattern of dots along the rim and a plaited band design along the handle. In fabric, however, they are excellent. These vases must all be assigned to L.H.III B because of their association.

We first began to examine the so-called Cyclopean Terrace Building in the short campaign of 1923. In 1950 at the request of Dr. Papademetriou we undertook further work there in order to supplement Mr. Petsas' investigations in the house he had discovered further to the west with storerooms full of unused vases. In 1951 Mr. Sinclair Hood did some more experimental work in order to try to define the area of the building. In doing so he discovered the corner of a storeroom containing tall pithoi and large stirrup jars like those in the House of the Oil Merchant. In 1952 work was continued on the site and interesting discoveries were made. The site is difficult to excavate. It lies at the bottom of a terraced slope and continuous cultivation and stone robbers have much affected the ruins.

The part called the North Megaron which resembles a megaron in plan consists of tall foundation walls over three meters high and 1.50 m. wide which must have supported some important structure, perhaps a megaron. Into the space enclosed by these walls was thrown a fill of stones and the whole, walls and fill, must have been the foundation for some solid structure above, all traces of which have now perished. The walls on the east rest on rock, but elsewhere on earth. In the southwest corner a floor level several times renewed lay level with the top of the rock to the east. Beneath this floor was a deposit of pottery, which gives a terminus *post quem* for the building of the great walls. The pottery is markedly homogeneous in character and runs in date from late L.H.II to L.H.III A. Since in the top of the fill between the walls L.H.III C burials were found in 1923 the building of the walls must date from the intervening period, in other words from L.H.III B. In 1952 part of the fill in the southern or back room of this North Megaron was excavated and

though the deposit of pottery was not found to continue southwards on the same scale there was nothing to conflict with this proposed dating.

The area adjoining the North Megaron to the east has not yet been sufficiently tested, but the natural slope of the hill here seems very steep. To the southwest of the North Megaron a large terrace wall runs roughly north and south and in construction it does not appear to differ much from the walls of the North Megaron. At its western foot was found a ruined storeroom which seems to have been wantonly destroyed. As yet no walls to define the limits of this storeroom have been found, but it was clearly large for the length at present excavated is ten meters. It would appear that the Cyclopean terrace wall along its east side was built partly over its ruins after it had been destroyed. In this storeroom, called The House of the Wine Merchant, were found over fifty large stirrup jars about 0.40–0.45 m. high. Some are complete, others mashed to pieces. Some of the broken jars lay in a heap at the foot of the terrace wall. Others lay scattered among or inside the broken remains of large pithoi which had stood in the room. Of these pithoi there were at least eight. They measure 1.70 m. in height and had small bases, wide bodies, open mouths. They were supported by rectangular, almost square blocks, of whitish yellow clay placed irregularly about the room. The clay blocks are of varying heights, and their irregularity is striking. Some undoubtedly served to support the pithoi. Perhaps others were used as convenient bases on which to stand jars for filling or pouring. The stirrup jars differ in types; some have white decoration on a red or a blackish ground, others a brownish decoration on an oatmeal ground. In spite of this variation they were uniform in fabric and, like those from the House of the Oil Merchant, are to be considered to be of local Mycenaean fabric. Only one shows a marked difference in fabric and presumably is an import from elsewhere. It might even be Cretan. Among the stirrup jars lay a fine rhyton, which though broken is complete except for the tip at the bottom. It is 0.55 m. long with the handle and is of pinkish clay with a buff slip and is decorated with a bold octopus pattern in red brown picked out with white paint. Above and below there are bands of thick and thin horizontal lines and the overhanging rim bears a dart-like pattern. This rhyton may perhaps have been used to fill the stirrup jars from the big pithoi. The rhyton is of L.H.III B date and should probably be assigned to the earlier part of that phase. Thus the stirrup jars and the pithoi and the building in which they lay should also be assigned to the same period. This would not be inconsistent with the date of the pottery below the fill of the North Megaron.

The history of the whole area is still most obscure. The walls of the North Megaron are presumably L.H.III B and so is the storeroom with the stirrup jars. The Cyclopean terrace wall which runs along the east side of the storeroom of the House of the Wine Merchant is presumably later, but can it also be L.H.III B? Finally after the buildings were destroyed burials took place in L.H.III C times in the top of the fill. Further patient excavation is needed to solve these problems, for the site is difficult and has suffered so much from cultivation and the work of stone robbers.

Among the stirrup jars in the House of the Wine Merchant were found over eighty discs chipped from broken pottery or from stone. Discs like this are not uncommonly found in small numbers on Mycenaean sites and are usually called counters for playing games. It is hard, however, to see what game could be played with over eighty counters and it is not easy to see why they should be in a storeroom with stirrup jars and pithoi. A more probable explanation is that they served as covers for the tops of jars or for the spouts of stirrup jars. At the Menelaion at Sparta in 1910 were found some sealed clay caps that had covered jars. The method employed seems to have been as follows. First the disc was laid on the top of the jar or spout. This was covered with vine leaves. Over these was applied a thick cap of clay to make the whole airtight. The clay then while still damp was sealed several times with a signet to prevent tampering and perhaps also to indicate the origin or the ownership of the contents. The cap was fastened in place by cords. It will be seen that this method differs somewhat from that used for the oil jars in the House of the Oil Merchant described above. Possibly the difference of method is to be accounted for by the difference of contents, oil as against some other liquid, wine for instance, as conjectured in this case. The stirrup jars in this house certainly had not contained oil, for their clay is not impregnated with oil like the other stirrup jars.

Future excavation on this site will no doubt throw more light on such problems and above all on the question whether the Wine Merchant like the Oil Merchant was literate and employed the Linear B script for his accounts.

# ATHENS AND THE HELLENISTIC PRINCES

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(*Read November 13, 1952*)

THE theme of this paper is one aspect of the relations between the old cities of Greece and the princes who ruled over the several states into which the empire of Alexander the Great disintegrated.[1] Their dealings with one another constitute an interesting chapter in the history of international relations and one that was significant in two respects: it was from the ripe old city states that the princes gathered the seed for a new Hellenic culture which they proceeded to sow over a vast area of the Near East; on the other hand, the well being and at times the very existence of the cities depended on the favor of the princes.[2]

Within the given limits of space we can hope to look at only one of the two faces of the medal and, having to choose, I have elected to discuss some of the things which the princes did for the cities. This in the long run was probably of less importance than what the cities did for the princes, but for the aspect which I have chosen the evidence is more concrete and more tractable.

The picture is not entirely cheerful. Some of the kings were consistently ill disposed toward the old cities in general, other kings treated certain cities outrageously, suppressing their liberties, robbing them of their territories, imposing ruinous taxes. Perhaps more often than not, however, the princes displayed extraordinary generosity toward the cities. Their benefactions are remarkable in number, variety and costliness. They took the form of outright gifts of money, or of grants earmarked for some specific purpose such as the purchase of food, or ships, or the cost of education. Commonly the gifts were more spectacular and permanent: gardens, sculptured monuments and, above all, public buildings, particularly of a kind that served the needs of the citizens at large.

We are for the most part inadequately informed as to the circumstances under which such benefactions were made. The literary references are normally laconic; the inscriptions engraved on the buildings and monuments are mere formulae; the relevant correspondence, which was sometimes published on marble, is likely to be stereotyped or tendencious.[3]

Among the most illuminating of the surviving written records is a series of inscriptions found by the French at Delphi, where they had been engraved on monument bases soon after 160 B.C.[4] They tell of deputations sent by the people of Delphi to Eumenes II and Attalos II, Kings of Pergamon in Asia Minor, to ask for financial help in buying grain, in repairing the monuments of the sanctuary of Apollo and in paying the school teachers of Delphi. Particularly interesting is the fact that Eumenes, after undertaking in response to the first embassy to pay both for grain and for the repair of buildings, carried out only the first part of his commitment and had to be reminded of the other part by a second embassy. The tact of the delegates was matched by the generosity of the king, who soon paid up in full, and both kings were honored in return by the establishment of annual festivals bearing their names at Delphi. These festivals, however, were endowed by additional grants from the kings. Apart from the nature of the acknowledgment, the record is not a little anticipatory of present-day negotiations with the great foundations.

The motives which prompted the gifts must for the most part be a matter of speculation. At times, no doubt, and especially in the earlier centuries when certain of the cities still retained a good deal of political and military importance, the benefactions were intended to ensure for the king the

[1] I owe the photographs for figures 7, 8, and 10 to the American School of Classical Studies at Athens, those for figures 4, 5, and 11 to Miss Alison Frantz.

[2] *Cf.*, in general, the relevant chapters in the *Cambridge Ancient History* **6** (1927), **7** (1928), and **8** (1930), especially those by W. S. Ferguson, M. Rostovtzeff and W. W. Tarn. For a briefer review *cf.* W. W. Tarn and G. T. Griffith, *Hellenistic civilization*, ed. 3, chap. II and III, London, Arnold, 1952.

[3] The letters have been conveniently assembled, and translated, by C. B. Welles, *Royal correspondence in the Hellenistic period*, New Haven, Yale Univ. Press, 1934.

[4] W. Dittenberger, *Sylloge Inscriptionum Graecarum* **2**: nos. 671, 672 (ed. Pomtow), Leipzig, Hirzel, 1917; G. Daux, *Delphes au II^e et au I^er Siècle*, 497–511, 682–698, Paris, Boccard, 1936.

goodwill of the city in future crises. Thus Antiochos II, in a letter in which he granted the city of Erythrae autonomy and a reduction in taxes, expressed the hope "that you will remember suitably those by whom you have been benefited." [5]

The cost of certain of the great market halls erected by the kings on the island of Delos, which was then a busy center of international trade, would probably today be entered under the heading of publicity.

More commonly the donors appear to have been motivated by a desire for personal display, a frailty to which wealthy Greeks both in ancient and in modern times have been commonly, if not exclusively, subject. The Greek cities in several instances would seem to have known how to exploit this weakness through encouraging a fruitful rivalry among potential donors. The kings have very frankly admitted their concern for their own glory in some of their letters which have come down to us on marble. Thus Eumenes II of Pergamon, in accepting honors voted to him by the cities of the Ionian League in 167/6 B.C., wrote:

> In order that for the future, by celebrating a day in my honor in the Panionian Festival you may make the occasion more illustrious, I shall present you with an adequate income from which you will be able to remember us suitably. I shall myself make the gold statue, because I desire that the honor should cost the League nothing and I wish to have it set up in the precinct voted to us by Miletos.[6]

Oftentimes, however, the motives of the princes were less self-centred. The grandfather of Eumenes II, for instance, had begun the practice of subsidizing the Academy at Athens and his father had provided for the head of the Academy a garden which bore the name not of the king but of the philosopher Lakydes.[7] It was the custom, indeed, for the young princes of the royal house of Pergamon to study in Athens so that such benefactions might be compared with those made to our universities by distinguished alumni, and the spirit behind them might be more specifically compared with the attitude of Rhodes scholars toward Oxford. In other cases benefactions were undoubtedly inspired by genuine gratitude on the part of the princes for the intellectual and cultural debt which they and their people owed to the old cities of Greece.

[5] Welles, *Royal correspondence*, no. 15, 1, 34.
[6] Welles, *Royal correspondence*, no. 52, ll. 50–60.
[7] Diogenes Laertius, IV, 60.

Of all these cities, Athens had been most influential as a centre of art and learning, and none was more potent than Athens in making known the good works of princes. "Athens, like a beacon tower of the world, would by her fame speedily flash the report of their deeds to all mankind," declared Antigonos the One-eyed.[8]

From here on, therefore, I should like to concentrate on Athens. By referring to a few of the royal foundations I shall hope to give some indication of their variety and scale and of their prominence in the overall design of the city.[9]

Alexander the Great did not live to carry out any great undertaking in Athens, but, in addition to his general regard for the liberties of the Greek cities, he was drawn to Athens by a romantic admiration for the old town where his tutor Aristotle had lived and taught so long. On his father's bidding he had carried back to Athens the ashes of the Athenians who had fallen at Chaironeia: a difficult diplomatic mission which he performed with such tact that the Athenians shortly afterwards honored him with a statue of which the head has been found on the Acropolis (fig. 1).[10] This marble shows him younger than any other of the many surviving portraits, and more human. In the course of his reign Alexander gave repeated indications of his regard for Athens, each marked by his native perspicacity and sense of the dramatic. His first issue of gold coins bore the head of Athena on their obverse, a peculiarly Athenian type of Victory on the reverse.[11] We hear of his sending to Athens after the Battle of the Granikos 300 Persian panoplies as a special gift to Athena. It may be that it was some of the shields from this booty that have left telltale marks at twenty-six points on the architrave of the Parthenon.[12]

[8] Plutarch, *Demetrius*, VIII, 2.
[9] W. S. Ferguson, *Hellenistic Athens*, London, Macmillan, 1911, is still the best account in English. *Cf.* also C. Wachsmuth, *Die Stadt Athen im Alterthum* **1**: 608–686, Leipzig, Teubner, 1874; W. Judeich, *Topographie von Athen*, ed. 2, 88–103, Munich, Beck, 1931.
[10] M. Bieber, The portraits of Alexander the Great, *Proc. Amer. Philos. Soc.* **93**: 380, 1949; B. Ashmole, Demeter of Cnidus, *Jour. Hellenic Studies* **71**: 15 f., 1951.
[11] C. Seltman, *Greek Coins*, 204 f., London, Methuen, 1933; H. A. Thompson, *Athenian studies presented to William Scott Ferguson* (Harvard Stud. in Class. Philol., Supp. vol. I), 206 f., Cambridge, Mass., 1940.
[12] A. Michaelis, *Der Parthenon*, 15, 42, Leipzig, Breitkopf und Härtel, 1870–71; Wachsmuth, *Stadt Athen.* **1**: 603; F. Penrose, *The principles of Athenian architecture*, ed. 2, 15, London, Macmillan, 1888.

FIG. 1. Head of Alexander found on the Acropolis. (*Jour. Hellenistic Stud.* **71**: pl. XII, a, 1951.)

Alexander made his most dramatic gesture toward Athens after his capture of Babylon, the Persian capital, in 331 B.C. There among the spoil carried off by the Persians from Athens in 480 B.C. was a pair of bronze statues honoring the Tyrannicides, who had assassinated Hipparchos, a member of the Athenian tyrant's family, in 514 B.C. The original group, made *ca.* 510 B.C., had taken such a hold on the minds of the citizens that it had been replaced after the Persian invasion with a second group. After Alexander's return of the stolen property the two pairs of statues stood together in the market square through the remainder of antiquity, by all odds the most famous and popular groups of sculpture in the city; as such they were repeatedly copied and echoed in various media.[13]

The Tyrannicides were conceived as a symbol of liberation. By an ironical turn of fate, less than ten years after Alexander's restoration of the group from Babylon, Athens was occupied and garrisoned by Macedonian troops.

[13] G. M. A. Richter, *The sculpture and sculptors of the Greeks*, ed. 2, 199–201, New Haven, Yale Univ. Press, 1950. An inscribed fragment from the plinth of one of the groups came to light in 1936 in the north central part of the Agora (*Hesperia* **5**: 355–358, 1936) but the actual bases have yet to be found.

When the tyrants were expelled from Athens in 510 B.C. they had left unfinished an enormous temple of Olympian Zeus. In one of the dialogues of Lucian, Zeus asks the Athenians, rather peevishly, whether they intend to complete his dwelling.[14] This embarrassing situation was regarded as a challenge by Antiochos IV Epiphanes, King of Syria (175–164 B.C.), who, according to Polybios (XXVI, 1, 10), surpassed all the kings in the attention which he paid to the gods and to the Greek cities (fig. 2). Even Antiochos did not live to finish the temple. But he was praised by Livy (XLI, 20, 8) for having advanced the construction of the one temple in all the world that was in keeping with the dignity of Zeus. The building, as eventually finished by the Emperor Hadrian, was indeed one of the half dozen largest temples in the Greek world, and the fifteen columns which still stand, each over fifty-five feet in height, consti-

FIG. 2. Antiochos IV Epiphanes. (*British Museum Catalogue of Greek Coins, Seleucid Kings of Syria*, pl. XI, 1.)

FIG. 3. Eumenes II. (*Ibid., Mysia*, pl. XXIV, 5.)

tute the most dramatic ruin in the city (fig. 4). Before embarking on this enterprise Antiochos had spent some time in Rome and it is of no little interest that he called upon a Roman architect, Cossutius, to supervise the construction.[15] This is one of several instances in which East and West made a fruitful meeting in Hellenistic Athens.

Eumenes II, King of Pergamon (197–159 B.C.), was a lifelong friend and ally of Antiochos and one of the few princes who could rival Antiochos in his benefactions to Athens (fig. 3).[16] In Athens one remembers Eumenes chiefly for the great colonnade which bears his name at the south foot of the

[14] *Icaromenippus*, 24.

[15] W. B. Dinsmoor, *The architecture of ancient Greece*, 280 f., London, Batsford, 1950.

[16] On the building activity of the Pergamenes *cf.* E. V. Hansen, *The Attalids of Pergamon*, Ithaca, Cornell Univ. Press, 1947, especially pp. 262–274: "Buildings of the Attalids outside Pergamon."

FIG. 4. Olympieion from the Southwest.

Acropolis (fig. 5). It was intended as a promenade for the audiences at the open-air theatre of Dionysos and particularly as a refuge in case of rain. The need for it will be clearer when I remind you that the theatre in this period was used both for dramatic performances and for meetings

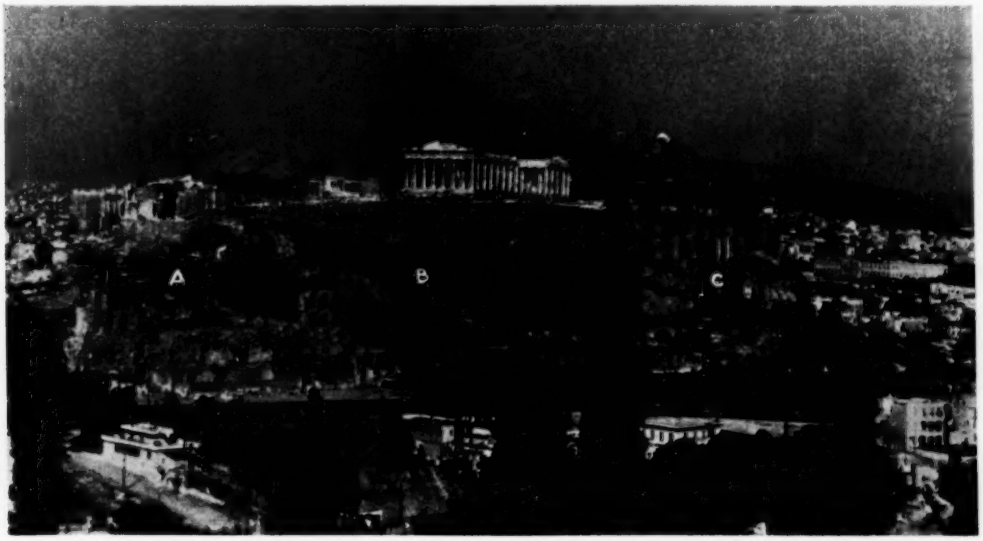


FIG. 5. Acropolis: South side from the Pnyx. A: Odeion of Herodes; B: Stoa of Eumenes; C: Theatre of Dionysos.

of the political assembly; it could seat ten or twelve thousand people. The colonnade comprised two storeys so disposed against the hillside as to be readily accessible from the theatre at two levels. In the second century after Christ, Herodes Atticus placed his great concert hall in such a way that its audiences also might avail themselves of the colonnade. Let me point out that Eumenes' building was protected by the Acropolis from the cold north wind and that it was set high enough to command an agreeable view southward toward the sea.

Little enough of Eumenes' stoa remains and even that little has not yet received a worthy study.[17] This, indeed, is one of several great things to be done in Athenian topography. Consider, for instance, the back wall of the colonnade, or rather the arcaded retaining wall which intervened between the visible back wall of the building and the steep slope of the Acropolis. In structure this must remind one of the great arched aqueducts which sweep across the Roman Campagna and in fact it is contemporary with the first known use of stone arcades in the aqueducts of Rome.[18] Whether this type of construction originated in Rome or in the Greek east is still a moot question. But it is worth pointing out that arcaded retaining walls of the same type were employed by Eumenes II at home in Pergamon to support the side of the sanctuary of Athena which flanked the theatre (fig. 6).[19] Moreover, the two-storeyed colonnade

[17] For a brief description and bibliography *cf.* Judeich, *Topographie*, ed. 2, 325 f. With the appearance of the forthcoming study of the better preserved Stoa of Attalos II in the Athenian Agora the time will be ripe for a new and comprehensive work on Eumenes' building.

[18] M. E. Blake, *Ancient Roman construction in Italy from the prehistoric period to Augustus*, 198, 219 f., Washington, Carnegie Inst., 1947.

[19] R. Bohn, *Altertümer von Pergamon IV: Die Theater-Terrasse*, 6, Berlin, Spemann, 1896. W. Zschietzschmann (Pauly-Wissowa-Kroll, *Real-Encyclopädie* **19** (1), Stuttgart, Metzlersche Verlagsbuchhandlung, 1937, col. 1260) assigns the arcaded walls to a Roman reconstruction, but H. Kähler (*Der grosse Fries von Pergamon*, pl. 65, Berlin, Gebr. Mann, 1948) has indicated them as of the time of Eumenes, *ca.* 180 B.C. Similar construction was occasionally employed in fortification walls of the Hellenistic

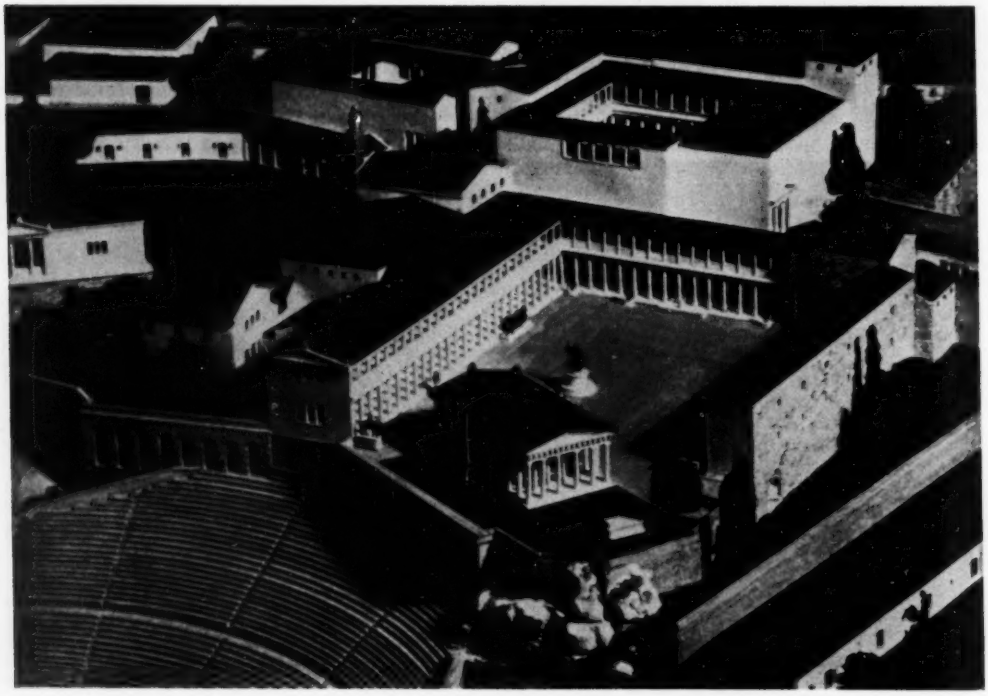

FIG. 6. Upper City of Pergamon: Model by Schleif. (M. Rostovtzeff, *Social and Economic History of the Hellenistic World* **2**: pl. LXX, 1, Oxford, Clarendon Press. 1941.)

FIG. 7. Stoa of Attalos II: northern two-thirds of building restored as Agora Museum. (Drawing by John Travlos and W. Stuart Thompson.)

which was erected by the same Eumenes along two sides of the sanctuary of Athena in Pergamon is so similar in design and in technical execution to his building in Athens as to prove that the king had sent an architect, perhaps even a construction foreman, to carry out the Athenian project.

Very soon after Eumenes had so greatly improved the theatre accommodations on the south slope of the Acropolis at Athens his younger brother and successor, Attalos II (159–138 B.C.), undertook a work of equal magnitude in the market-place or Agora to the north of the Acropolis. Attalos' contribution was another of those great colonnades or stoas in which the Pergamene architects specialized (fig. 7).[20] It formed part of a far-reaching program for the remodelling of the market square of Athens which was carried out in the second century B.C. More specifically Attalos' building closed the east side of the square with a marble façade some 380 feet in length (fig. 8). The surviving blocks from the superstructure provide a plethora of evidence for the paper reconstruction of the building which has already been carried out. The drawn reconstruction will indicate that Attalos' stoa, like that of his brother, was two storeys in height. In addition to housing forty-two shops it provided a magnificent screen for the east side of the plaza and the deep continuous porches which ran in front of the shops afforded room for hundreds of citizens to promenade in full view of the busy square.

The American School of Classical Studies, which is now rapidly completing the exploration of the market square, has designs on this building. It plans to reconstruct the Stoa as a museum to house the more than 60,000 objects recovered from the excavation of the site. The cost of rebuilding has been estimated at 1¼ million dollars. To face the problem of raising such a sum even today may well enhance one's opinion of the energy and financial resources of the kings of Pergamon and will sufficiently account for the pride with which Attalos had his name engraved on the lower architrave of the façade.

In the now ruinous north end of the Stoa of Attalos stands a marble block which once supported a seated bronze statue (fig. 10).[21] Accord-

period, a good example being the "White Poros Wall" on the Pnyx hill which has been dated toward the end of the third century B.C., i.e. just a few years before the time of the Stoa of Eumenes (R. L. Scranton, Stoas and city walls on the Pnyx, *Hesperia* **12**: 340–362, 1943).

[20] For a summary account of the building, a plan and references to the earlier literature *cf.* Judeich, *Topographie*, ed. 2, 354–356. Some of the results of studies based on the new evidence produced by the current excavations in the Agora are embodied in H. A. Thompson, Stoa of Attalos, *Archaeology* **2**: 124–130, 1949. A comprehensive new publication should appear shortly in *Hesperia*.

[21] *Inscriptiones Graecae*, II², 3781; Dittenberger, *Sylloge* **3**: no. 666; *Archaeology* **2**: 130, 1949.

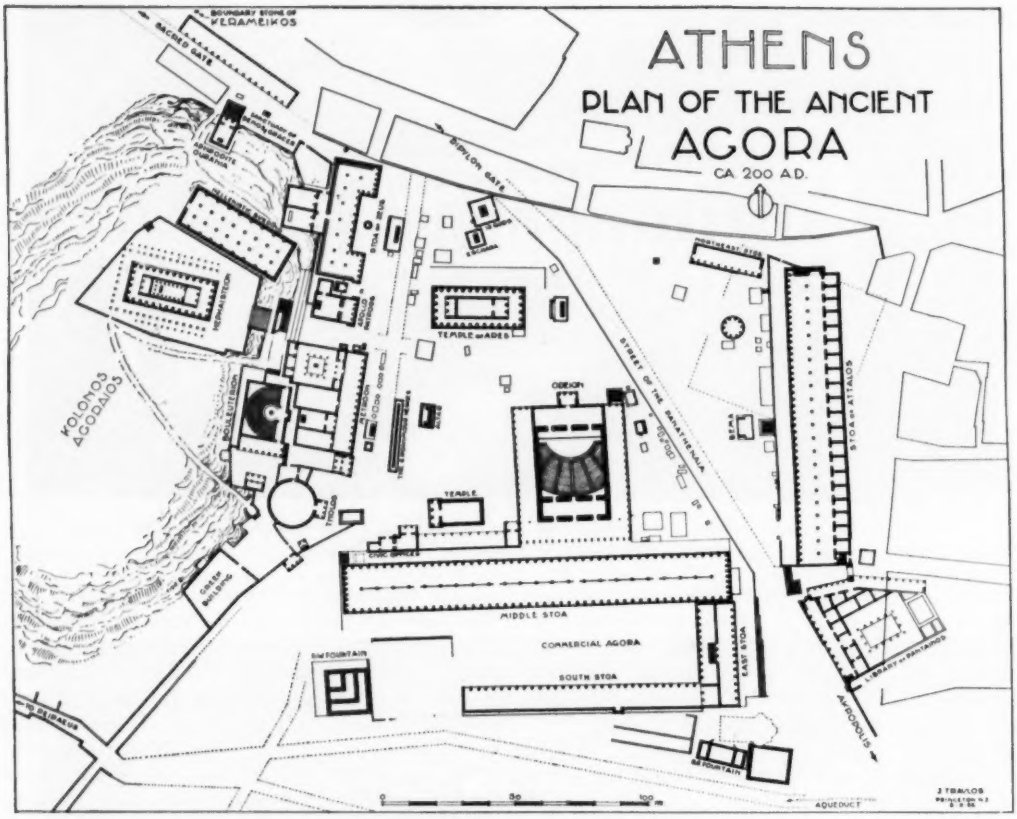


FIG. 8. Plan of Athenian Agora.

ing to the inscription on its front the man honored was Karneades, head of the New Academy and the leading philosopher of the world in the second century B.C. The names of the two dedicators are likewise given. One was Attalos II, the builder of the Stoa; the other was Ariarathes V, King of Cappadocia in Asia Minor (163–130 B.C.). These two men had sat together as youths at the feet of Karneades, and we may surmise that it was the memory of those days that led Attalos on ascending the throne to make his splendid gift. It is also conceivable, to be sure, that Attalos, like many a distinguished alumnus of today, was guided in his thinking in this matter. The original statue, being of bronze, has long since vanished, but copies of its bust remain (fig. 9). Cicero mentioned the statue as one of the vivid memories of his Athenian days [22] and clearly indicated his esteem for the philosopher by basing the third book of his *de Republica* on a famous series of lectures which Karneades had given in Rome a hundred years before. Here then, once more, we find in Athens a link between East and West.

The most famous group of sculpture in Athens, the largest temple, the splendid promenade by the theatre, the most magnificent of the buildings that bordered the market square, with all these are associated the names of eastern kings. It is scarcely surprising therefore that the most conspicuous tomb in Athens, indeed in all Greece, should also bear the name of a king: Antiochos Philopappos, ruler in name, though never in fact, of a tiny kingdom in the easternmost highlands of Anatolia. He had passed many years in Rome and had been named consul. He spent his latter years in Athens where he also attained to the chief magistracy and died between 114 and 116 after

[22] *de Finibus* **5**: 2.

FIG. 9. Karneades: from a cast in Copenhagen. (K. Schefold, *Bildnisse der antiken Dichter, Redner und Denker*, Basel, Benno Schwabe, 1943.)

Christ. In view of his public benefactions his memory was honored by the grateful citizens with a remarkable marble tomb which stood within the city walls on the highest point after the Acropolis itself.[23] Its ruins may still be seen, silhouetted against the sky, from many points in Athens (fig. 11). The choice of this lofty site, quite without precedent in Athens, was doubtless suggested by the practice of Philopappos' eastern homeland where the royal sepulchres are found on the very highest points in the kingdom. The inspiration for the architectural scheme of the tomb, however, must be sought elsewhere. Of the tower-like burial chamber the best preserved part is the curiously concave and richly articulated façade. In the middle storey is a sculptured representation of the funeral procession. Above, in the middle, sits the king, deified and flanked originally both to right and to left by a royal ancestor. A new study of the monument shows clearly that the façade in both its architectural and sculptural composition has so much in common with the triumphal arches and the theatres of Italy as to leave little doubt that it was designed by some outstanding architect from Rome. Philopappos, therefore, the last of the Hellenistic princes, even in his sepulchre has brought together the East and the West here in Athens. And who shall blame him for having chosen to sit through eternity gazing at the Acropolis?

[23] Judeich, *Topographie*, ed. 2, 388 f.; P. Graindor, *Athènes de Tibère à Trajan*, Cairo, Misr, 1931, pp. 166–169; M. Santangelo, *Annuario della Scuola archeologica Italiana d'Atene*, nuova serie (1941–1943), **3–5**: 155–253, 1948. A new study by John Travlos and the undersigned is nearing completion.

FIG. 10. Base of statue of Karneades found in Stoa of Attalos.

FIG. 11. Monument of Philopappos at Athens.

# SENECA INDIAN SINGING TOOLS AT COLDSPRING LONGHOUSE[1]

## Musical Instruments of the Modern Iroquois

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THE Allegany Seneca are indistinguishable in many ways from the surrounding non-Indian farmers of western New York State. One of the most striking differences found in non-Christian Seneca homes, however, is the presence of traditional Iroquois musical instruments, a condition accentuated by the almost total lack of instruments of European types. This paper deals with the form, construction, and use of such Seneca "singing tools" (*yõtẽnotáhkhwa?shõ?õ*, 'those things used for propping up songs').[2] The data presented here are based primarily on our observation of the instruments in use during the 1952 Midwinter Ceremonies in the longhouse. In order to obtain additional information, informants were interviewed, examples of the instruments were examined and collected, and wire recordings of their use were made. Here also primary emphasis was placed on the instruments employed in the longhouse during the Indian New Year "doings" although some attention was paid to other Allegany musical and sound instruments. In both observations and interviews our investigations were guided by the outline appended to this paper.[3]

While a great body of anthropological literature exists on the Iroquois,[4] there is no adequate discussion of their musical instruments. This is surprising in view of the striking resistance to change of this aspect of Iroquois culture. Attention was directed to the significance of such phenomena in current Iroquoian studies by William N. Fenton in a stimulating paper, "Stability and Change in Iroquois Culture History," presented to the Seventh Conference on Iroquois Research, at Red House, New York, in October 1951.[5]

In all, there are eighteen types of singing tools and other sound-producing instruments used today by the Allegany Seneca followers of the Handsome

[1] This paper is based on eleven days' field work at the Allegany Seneca Reservation in Cattaraugus County, New York. Both authors attended nine days, January 31 through February 8, 1952, of the annual Midwinter Ceremonies in the longhouse at Coldspring (between Red House and Quaker Bridge on State Highway 280). We are indebted to the Yale Peabody Museum for financial assistance. We also wish to thank our longhouse friends Albert Jones (*hanotyé·ne?s*), Geneva Jones (*kowõ·konyẽ̃ẽstha?*), Ed Curry (*shoõwõ?õ*), Lindsey Dowdy (*háiwasno·we?*), Herbert Dowdy (*tsha?towí·wahtõ?*), Avery Jimmerson (*sháẽ?ko?*), and Lena "Sibie" Snow (*kaweniyó?ah*) (see Speck, 1949a); and Charles E. Congdon (*hãõwõ?ko·wa*) of Salamanca, New York, for their hospitality and cooperation in this project. We are particularly grateful to William N. Fenton for introducing us to the Allegany Seneca and for criticizing the first draft of this paper.

Our orthography derives from a preliminary phonemicization of Seneca by Floyd G. Lounsbury, who kindly made available to us his previous notes on this language. There are five vowels which are either oral or nasalized depending upon their phonemic environment, namely, *i*, *e*, *æ*, *o*, and *a*; and two vowels which are always nasalized, namely, *ẽ* and *õ*. Other vowels adjacent to *ẽ* or *õ* are phonetically nasalized, but *e* and *o* in this environment have somewhat different qualities from *ẽ* and *õ*. Long vowels are written with · following the vowel symbol; double-pulse vowels are written with two vowel symbols. The consonants are: stops *t*, *k*, *?*; spirants *s*, *h*; nasal *n*; semivowels *w*, *y*. The consonants *t*, *k*, and *s* before vowels, *y*, *w*, and *n* are voiced or intermediate; before each other or *s* or *h* they are voiceless and more fortis; they do not occur before *?*. The phonemic combination *ty* is phonetically [j]. The phonemics of accent is not clearly understood; high pitch and loud stress are here indicated as carefully as possible by an acute accent over the vowel of the accented syllable.

[2] Words written within double quotes are English expressions used by the Coldspring Seneca. Words written within single quotes are translations of Seneca expressions.

[3] In drawing this up, valuable suggestions were obtained from Osgood, 1940: 56–61, and from Ford, 1937.

[4] For the best general treatment of Seneca ethnography, see Morgan, 1901. For a discussion of the Longhouse religion see Parker, 1913 and Deardorff, 1951. For an analysis of the forms and meanings of the Midwinter Ceremonies at Coldspring and of other rites at this longhouse see Fenton, 1936. For comparative data on recent Midwinter Festivals at other longhouses, see Fenton, 1941*b*, and Speck, 1949*b*. For longhouse music see Baker, 1882; Beauchamp, 1907; Burke, 1937; Cringan, 1898, 1900, 1903; Fenton, 1942*a-b*, 1948*a-b*; Herzog, 1942; Huot, 1948; Kurath, 1951; Roberts, 1933; Starr, 1905. For brief discussion of present-day Iroquois musical instruments see Fenton, 1941*a*: 424f; Fenton, 1942*a*: 9–11; Fenton, 1953; Lyford, 1945: 36–38; Morris, 1914: 126, 141, 155–161, 167, 168, 184; Parker, 1913: 113–130; Speck, 1945: 77–82; Speck, 1949*b*: 42–45; Tahamont, [1940?].

[5] Fenton, 1951.

Lake Religion. Of these eighteen types, eleven are used in the longhouse during the Midwinter Ceremonies. Two, leg pellet bells and cane sticks, are not considered *yõtẽnotáhkhwa?shõ?õ*. The other nine are all singing tools: the great turtle rattle (and its substitutes, the bark rattle, the tempo beater, the tin rattle, and the wooden turtle rattle), the water drum, the horn rattle, the box turtle rattle, and the stamping stick. The seven instruments not used in the longhouse during the Midwinter Ceremonies are the big water drum, the rasping sticks, the flute, the big gourd rattle (and its substitute, the coconut rattle), the little horn rattle, and the little gourd rattle.

The three most important instruments are the great turtle rattle, the water drum and the horn rattle. A record kept of the total time of their use in the longhouse during the entire 1952 Midwinter doings gave the following results:

| | |
|---|---|
| waterdrums | 3 hours 4 minutes |
| horn rattles | 2 hours 59 minutes |
| great turtle rattles | 1 hour 25 minutes |

By contrast, the figures for the other instruments observed are:

| | |
|---|---|
| box turtle rattles | 17 minutes |
| stamping sticks | 15 minutes |
| tempo beaters | 10 minutes |
| tin rattles | 3 minutes |

Despite the fact that the great turtle rattle was not used as much as the two other main singing tools, there are several reasons why it should be considered the most prominent of Seneca instruments. It alone is always used without instruments of other types. It is the most complex, in that it has the greatest number of component parts and takes the longest time to construct. It is played with the greatest vigor and the greatest affect and is the loudest of all instruments. The snapping turtle, of which it is constructed, has other important connotations to the Seneca. According to their cosmology, the earth itself rests upon its back. The members of the Turtle Sib, which is today the largest sib at Allegany, are "genuine turtles," i.e., snapping turtles.

Before considering each of the instruments in detail, the part that musical instruments as a whole play in the longhouse Midwinter Ceremonies may be summarized. The following time chart shows, for each of the nine days,[6] (1) the occupancy of the longhouse during and between ceremonies, (2) the total duration of actual ceremonial activity, not counting rest periods, and (3) the total amount of time during which musical instruments were being played. These figures are only approximate, especially in the third column from the left, since notes were not taken down in the longhouse.

An indication of the extent of participation in the longhouse activities by the Allegany Seneca is

[6] Nine days, rather than the possible eight, because the Bowl Game was not completed until the second day it was played. The preliminary day for the naming of children is not included. See Fenton, 1936: 10, 13.

TABLE I

USE OF INSTRUMENTS IN THE LONGHOUSE

| Day | Longhouse occupancy | | Duration of ceremonies | Playing of instruments |
|---|---|---|---|---|
| *1* Jan. 31 | 8:45–11:30 A.M. | 2 hrs. 45 min. | 1 hr. 10 min. | 5 min. |
| *2* Feb. 1 | 9:00 A.M.–12:00 N. | 3 hrs. | 35 min. | 0 |
| *3* Feb. 2 | 9:15–11:42 A.M. | 2 hrs. 27 min. | 1 hr. 9 min. | 38 min. |
| *4* Feb. 3 | 9:50–11:15 A.M. | 1 hr. 25 min. | 40 min. | 17 min. |
| *5* Feb. 4 | 9:35–11:30 A.M.<br>1:50– 3:22 P.M.<br>7:20–11:10 P.M. | 7 hrs. 17 min. | 4 hrs. 21 min. | 1 hr. 35 min. |
| *6* Feb. 5 | 10:25 A.M.–1:50 P.M. | 3 hrs. 25 min. | 2 hrs. 54 min. | 39 min. |
| *7* Feb. 6 | 9:30 A.M.– 1:50 P.M.<br>8:30 P.M.–10:20 P.M. | 6 hrs. 10 min. | 3 hrs. 40 min. | 1 hr. 25 min. |
| *8* Feb. 7 | 9:40 A.M.–5:30 P.M. | 7 hrs. 50 min. | 5 hrs. 30 min. | 17 min. |
| *9* Feb. 8 | 9:30 A.M.–12:55 P.M. | 3 hrs. 25 min. | 3 hrs. | 0 |
| Approximate totals: | 38 hours | | 22 hours | 5 hours (plus one hour of singing without instruments) |

given by the following tabulation of the approximate numbers of people present in the longhouse at the beginning of each day's ceremonial activities, and the maximum number present during the day:

| Day | Number at start | Maximum number |
|---|---|---|
| 1 | 11 | 18 |
| 2 | 8 | 20 |
| 3 | 7 | 35 |
| 4 | 6 | 25 |
| 5 | 11 | 150 |
| 6 | 40 | 80 |
| 7 | 8 | 160 |
| 8 | 5 | 50 |
| 9 | 6 | 25 |

## GREAT TURTLE RATTLE

Foremost of Seneca singing tools is the great turtle rattle, which serves as an essential property in False Face rites and in the performance of the Great Feather Dance.[7] It is made from the shell and other parts of a snapping turtle, *Chelydra serpentina* Linn., which is sometimes known locally as a mud turtle. Although in English we call this instrument a rattle, along with other shaken idiophones,[8] Seneca terminology emphasizes the difference in its appearance and construction (figs. 1, 2) contrasted with other types of Coldspring dance rattles (figs. 3, 4). Whereas other rattles are known generically as *kasláwē·ʔshæ·ʔ*, the great turtle rattle is always designated by the distinctive term *ká·ʔno·wa·ʔ*, 'turtle,' or more specifically, *kanyáhtē· ká·ʔno·wa·ʔ*, 'snapping-turtle turtle.'

The manufacture of these snapping turtle rattles, as of other Seneca instruments, is a secular affair. Only two or three men, however, specialize in such activities and it is to such specialists that other longhouse people bring live or dead turtles when they wish to have a rattle made. At Coldspring, Ed Curry is now the principal manufacturer of great turtle rattles, and it is from him that much of the following information was obtained.

If a buyer furnishes the turtle, the average price for making a rattle of medium size is $4.00. They range in price, however, from $3.00 to $20.00, depending on the materials used, the size of the rattle, and the case and time spent in making it.

The pellet-containing receptacle of the great turtle rattle is made from a whole shell of a snapping turtle, the skull and neck of which are stretched over a stick to form a handle. For de-

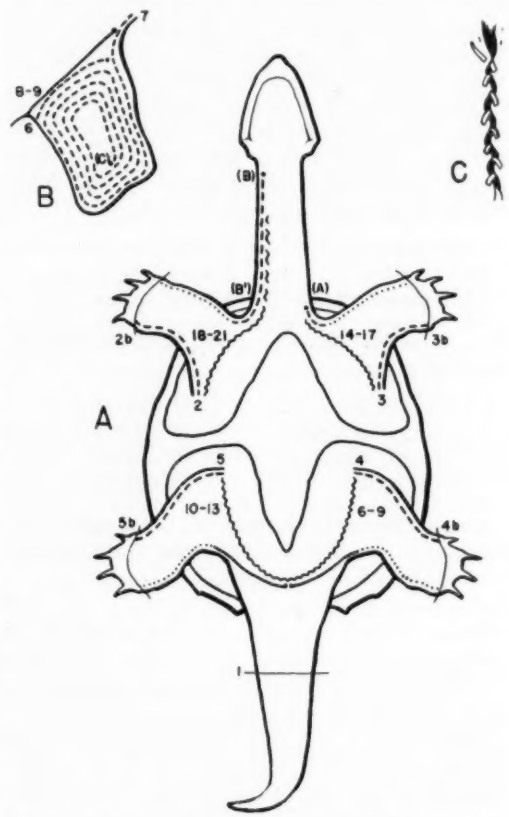


FIG. 1. Great turtle rattle construction diagram, showing technique and location of skin cuts and lacing: A, ventral view of snapping turtle, one-fourth actual size; B, inner skin flap of left hindlimb; C, self-lacing technique. Broken or continuous plain lines indicate cuts; solid lines show cuts through two skin surfaces, broken lines through only one (dashes show visible cuts, dots show portions of cuts on the opposite skin surface). Arabic numerals indicate, in sequence, the 21 individual cuts, and enlarged dots show where they terminate. Zigzag lines represent lacing. The numbers in B correspond with those in A. Other symbols are explained in the text.

[7] *ostowáʔko·wa*. For other longhouse ceremonies mentioned in this paper the following are the Seneca names together with the English translations we use: *kanéoowōʔ*, 'Thanksgiving Dance' ("Little Feather Dance" or "Second Feather Dance"; Drum Dance, Skin Dance, Harvest Dance); *ató·wēʔ*, 'Personal Chant' (Personal Thanksgiving); *thōwí·sas*, 'Women's Rite'; *ɛ́skæ·nyeʔ*, 'Traditional Women's Dance'; *onɛ́yōʔ oɛ̄nóʔ*, 'Corn Dance'; *káʔta·syot*, 'Stomp Dance' ("Number One Dance," "First Dance"); *kɛ̄tsóɛ̄noʔ*, 'Fish Dance'; *nekwayíh óɛ̄noʔ*, 'Bear Dance'; *tikiyá·ʔkoʔo óɛ̄noʔ*, 'Buffalo Dance'; *tyɛ̄hko·waʔ oɛ̄nóʔ*, 'Pigeon Dance.'

[8] Sachs, 1940.

scriptive purposes, the great turtle rattle may be said to consist of twelve parts (fig. 2, A, C), the first four being portions of the original turtle: (1) the tough outer shell or carapace, (2) the hard ventral plates comprising the plastron and bridge, (3) the turtle skin minus the tail and parts of the leg covering, (4) the skull, (5) a wooden neck rod replacing the cervical vertebrae and forming the handle core (6, 7) two top splints, (8) a single bottom splint, (9) handle wrapping, (10) and pellets, (11) lacing, and (12) a hanging string.

The Seneca say that when a snapping turtle is moulting, in late spring or early summer, its shell is soft, and hence unsuitable for the construction of durable rattles. January and February—March at the latest—are considered the best months for catching turtles with tough shells. Serviceable rattles can also be made from turtles caught during late summer, although turtle carapaces are then lighter in color and therefore somewhat less desirable. Several specimens of this type were in use at the 1952 Midwinter doings.

When the turtle is caught, it is hung from a limb by a piece of rope or wire around its neck. A frame can be made for this purpose if there is no tree nearby. In order to twist the wire around the turtle's neck for hanging, the head may first have to be pulled out of the body of the resisting, live reptile. About two-thirds of the tail (*ca.* 5" on a medium-sized specimen; see fig. 1, A, 1) is cut off so that the turtle will bleed freely. The jugular vein may be cut, too.

After a night of draining, the turtle is sufficiently weakened to eviscerate without waiting for the animal to die completely. A pocket knife is used to make the first body cut (fig. 1 : 2), while the turtle is still hanging tail down. The slit is made horizontally, with reference to the turtle's normal position on the ground, starting in the axilla, running up the posterior side of the right forelimb, circling the distal end of the limb just behind the claws (fig. 1, A, 2b), running down the anterior surface of the limb and up the side of the neck. Opening the neck facilitates evisceration, but is not always done (the cut may end at (B') instead of at (B) : fig. 1, A). The same process is repeated for the left forelimb (fig. 1 : 3), except that the cut usually stops at the base of the neck (fig. 1, (A)).

Looking down, the maker then uses a knife to scrape, scoop, and pull out the meat, bones, and viscera from the neck and thoracic region. The legs are disarticulated by twisting, or if one is in a hurry, they can be simply yanked out. Considerable care must be exercised in using a knife or the skin may be scraped too thin or punctured. The process is easier when working between the plastron and carapace than between flabby skin areas. The smaller the turtle the more difficult the cleaning process, because the maker may be forced to do much of the work with one or two fingers.

When all waste contents of the anterior half of the body have been removed, the whole carcass is hoisted up about a foot so that the posterior regions may be cut open and cleaned more readily. Then cuts are made over the hindlimbs, as in the diagram (fig. 1 : 4, 5). The remains of the tail are cut off and discarded. Sometimes, the tail stub is removed first before making the hindlimb cuts. To prevent later tearing, for ease in lacing, and to allow for later shrinkage, all cuts are kept at least 1" away from the plastron and carapace margins.

The rest of the meat and "insides" are scraped out through the single posterior slit. This leaves the body shell empty but open in three places (one posterior and two anterior rents). For lacing these apertures shut, rawhide thongs, fine copper wire, or cat gut (two violin A-strings, worth 40 or 50 cents each) may be used. A less expensive, more convenient, and preferred method ("the old way") is to make the lacing from the hind leg flaps still attached to the turtle carcass (fig. 1, B, C). There is enough potential ⅛" lacing in any two of the eight limb flaps to sew up all three rents, although the customary procedure is to use each of the four ventral flaps, cutting only the length of lacing needed to close the immediate opening and leaving one end (in each case, that nearest the bridge) attached to the original skin (fig. 1 : 6–9, 10–13, 14–17, 18–21). Thus, when actual sewing commences, the number of knots required is reduced by four.

This self-lacing is made with a sharp penknife or a heavy pair of scissors, beginning with the ventral flap of the left hindlimb (fig. 1, B). The first cut (fig. 1 : 6) starts near the posterior base of the flap and goes across to about one-eighth of an inch from the base of the opposite margin. The next cut (fig. 1 : 7) starts near the anterior end of the slit and parallels, on the inside, the original rent until it meets the first flap cut. The cut then goes around the edge of the now almost-separated flap in continuous spiral fashion until enough lacing to stitch up half of the posterior rent is made. The remaining tab of skin (after stopping at (C)

in fig. 1) is discarded and the uneven inside edges of the slit (fig. 1 : 8) are trimmed off. The dorsal flap of the left hindlimb is removed by a single cut at the base (fig. 1 : 9).

The right hindlimb flap and both forelimb flaps are treated in a similar manner. When the necessary self-lacing has been made, only the neck rod and the pellets have to be provided before the receptacle can be closed.

To dry up the inside and lessen the "odor," an astringent such as alum is often used at this stage. "This helps," says Ed Curry; "you've got just the ordinary turtle smell left."

The handle or neck rod is whittled from a piece of soft, light-weight wood such as maple or hickory. Round in cross section, the rod must not be made more than 1" in diameter lest the finished handle with skin, splints, and wrapping be too unwieldy to grasp. After removing the turtle from the wire or rope noose, the neck rod is inserted and is temporarily tied or tacked in place. The head end of the rod is always put in first so that the skull and neck can be stretched out "just right." Careful fitting of this stick, either flat against the skull or through the windpipe-throat region, requires close examination of the surfaces involved. The maker whittles the rod accordingly, frequently making a notch to ensure a tighter fit into the temporal spaces on either side of the saggital crest. The other end of the stick is either left unmodified to protrude several inches into the receptacle, or whittled so that the tip thins out and projects on the carapace side several inches beyond the main body of the rod. This projection is made to fit snugly into the foramina between the most anterior dorsal vertebrae (the "ribs") and the first neural plate of the carapace to which the former are fused.

Next, a good half handful of common wild cherry pits (Choke-cherry, *Prunus virginiana*, Linn.) is placed in the body cavity before lacing the skin areas shut. These "seeds" are gathered in June or July and are carefully dried over a stove in glass jars or similar containers for at least a year, being kept where it is "not too hot, not too cold." If not thoroughly dried, the seeds will rot or chip into tiny fragments and will have to be replaced after the rattle is used only a few times. Frequently, these choke-cherry pits are not placed in the receptacle interior until after all but one of the forelimb apertures have been laced up.

Finally, the rents are sewn together with the self-lacing. The only tool needed is an awl which is used to make the holes, spaced about ¼" apart through the softened skin on both sides of the split. If the lacing has become somewhat dried out, it can be softened in water—all but the tip, which is left hard and pointed to aid in stitching. The lacing proceeds in the same direction as the main cuts. Using a simple zigzag stitch, alternating from one edge to the other and going up through each hole from the inside (fig. 1, C), the slits are sewn up tightly. Excessive puckering at any one point is "evened out" with the fingers as much as possible.

Where the two hind laces come together in the tail region, they are tied together in a "simple knot" (granny knot), the ends snipped, and the tie then tucked out of sight. When each of the fore-rents is sewn up, the two laces are ended in overhand knots. It is not necessary to lace up the entire length of the neck because skin shrinkage and the outer handle wrapping will cover the whole neck and keep the grip strongly bound. If separate thongs are used for lacing, the starting ends are tied in overhand knots. Otherwise, the procedure followed is the same as with the self-lacing. The rough, bumpy appearance of the newly-laced areas disappears with drying as the skin draws out tight and even. If the original lacing is not pulled up close with each stitch, the slit edges may recede from each other as much as ⅛" by the time the rattle has thoroughly dried.

To keep the neck-handle from shrinking out of line and to keep it firmly attached to the receptacle-body, three splint braces of hickory, *Carya* sp. (*ovata*?), about half as long as the total length of the rattle and about ⅛" to 3/16" × ½" in cross section, are whittled out on a shave horse. The edges of the splints are slightly rounded, the head ends bevelled, and the body ends pointed. Three transverse knife slits are made through the hard parts of the turtle shell to receive the pointed ends of the splints. One slit is made between the hypoplastral bones of the plastron just anterior to the bridge connecting the plastron with the carapace (fig. 2, A); and two are pierced through the carapace. These latter slits are symmetrically placed on either side of, and immediately adjacent to, the first neural scute, on—or just anterior to—the cracks between the first and second costal shields (fig. 2, C). These slits are cut through both the horny outer scutes and the inner bony shields, at an inward-and-posteriorward angle to prevent excessive protrusion of the splints above the surface contour of the carapace. The slits must not be

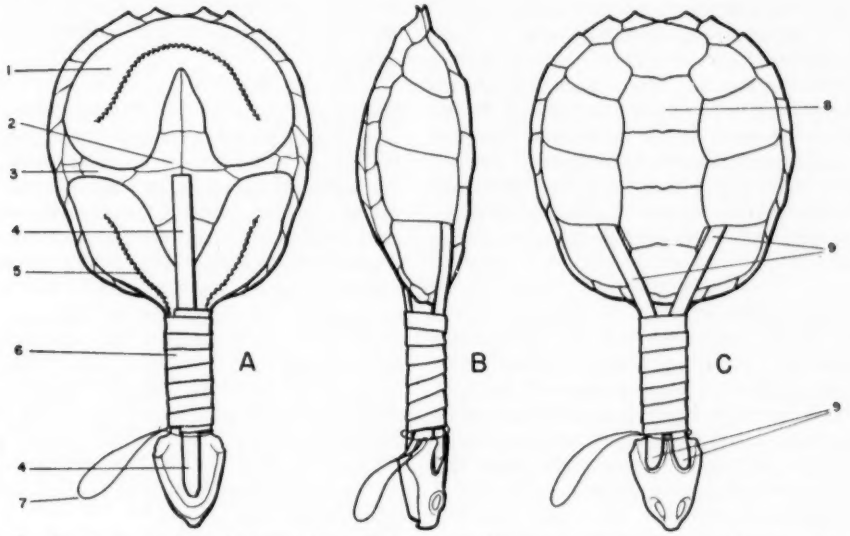


FIG. 2. Great turtle rattle, three views: A bottom, B side, C top; one-fourth actual size. A: 1, skin; 2, plastron; 3, bridge; 4, bottom splint; 5, lacing; 6, handle wrapping; 7, hanging string. C: 8, carapace; 9, top splints. For photographs see Densmore, 1927: pl. 8; Fenton, 1941*b*: pl. 23, 24; Lyford, 1945: illus. 36; Morris, 1914: facing p. 162; Speck, 1945: 78, 80; Speck, 1949*b*: pl. 5*a*-*b*, 14*a*-*b*. For a side view see Morgan, 1901: 1: 268.

too narrow or splintering of the shell may occur when the sharpened tips of the hickory strips are forced through for about an inch into the receptacle interior.

The bottom splint is straight, extending from the plastron to the space between the rami of the turtle's lower jaw. The two top splints are shaped, according to the size of the turtle, so that the head ends run parallel to each other along the axis of the handle and curve out from each other just above the handle wrapping in order to fit into the knife slits at an angle as close to 90° as possible (fig. 2, C). The head ends of all three splints are tied to the handle with a twist of bast or string until the outer wrapping is added.

For this handle wrapping, a ¼" rawhide thong, a softer leather strip, a long band of friction tape, or a strip of inner bark may be used. The strongest, cheapest, and traditionally best wrapping is made of a single, ½" to ¾" strip of the inner bark of a hickory or slippery elm, *Ulmus fulva*, Michx. Since the time to strip bark from such trees is in the late spring when the "sap is running up," and snapping turtles should not be caught until winter, the strips of inner bark are usually collected in the summer before rattles are to be made. When this is done, the 1" to 2" wide strips are coiled into tape-like rolls 4" or 5" in diameter and are hung up to dry. This manner of coiling prevents the strip margins from curling in. When the strips are needed, they are made pliable by soaking in a pan of water for about 20 minutes. They are then easily split into strips about ½" wide.

The rattle maker takes such a wet strip of inner bark and wraps it tightly around the handle, starting and ending with a double twist around the bottom splint (fig. 2, A). Wrapping always proceeds from the receptable toward the skull. No knots or splices are needed, and a tight, smooth, durable covering results, when the bark dries.

For hanging purposes a simple loop of old rag, string, leather, rawhide, or bast may be tied around the handle just behind the skull.

The cleaning and lacing of this type of rattle is done preferably within a day after killing the turtle, before desiccation starts and stiffening sets in. If the procedure is interrupted or delayed, the skin and shell must first be softened by soaking in water before any work on it can be resumed.

After lacing and binding, the rattle is hung up to dry in the sun. This takes at least two or three weeks even in good weather.

Sometimes the dried carapace and plastron are

coated with varnish or common "basket paint." This is not to cover up spots left where scutes have chipped off, but for "looks" or for ease in "dusting." Occasionally red, black, or brown spots, bands, and crosses may be painted on the carapace or plastron. This is entirely optional and no ritual significance is so indicated. In contrast with other singing tools, no great turtle rattles are decorated by means of carving, incising, or by the application—in any fashion—of names and dates.

The foregoing remarks on the construction of the great turtle rattle describe the present-day practices of the Coldspring Seneca. Minor variations, such as the Onondaga custom of placing a hanging cord through the eye sockets instead of around the neck, do occur in other Iroquois areas, but the basic procedure appears to be much the same wherever the snapping turtle is made into a sound instrument.

Excluding miniatures,[9] finished great turtle rattles range in total length from about 10″ to 20″, the average falling near 14″. For prolonged use in beating out song and dance rhythms, a small rattle about 12″ long is preferred. Larger rattles are more tiring on the wrists and arms. Large rattles from 15″ to 20″ in length are rarely used for continued rhythm beating, but are frequently carried by the False Faces (see below). Of the specimens measured—in all, some fifteen were seen in the longhouse and in various homes—the average dimensions were as follows: overall length, 14¼″; maximum length of carapace, 7½″; maximum width of carapace, 7″; thickness of receptacle at the center, 1⅞″; and length of grip, 4″.[10]

Of the three main Seneca instruments the great turtle rattle is the least durable and thus must be replaced most often. Nothing can be done to repair a rattle once the sides of the carapace and the bridge crack and the skin underparts tear from repeated use. The only parts that are commonly replaced or mended are the hanging string, the handle wrapping, and occasionally the lacing. In the last case the rattle is soaked in water to make the hide pliable before attempting to relace the opening.

The most distinctive, static feature shared by all great turtle rattles is their unmistakable, characteristic shape—viewed from any angle (see fig. 2, A, B, C). There are minor differences in color (though dark brown, or at least dullness, predominates), surface coating, details of construction, total dimensions; but the overall shape remains unmodified. Furthermore, whereas water drums and horn rattles are usually kept out of sight in rectangular bags, great turtle rattles are kept out in the open. Customarily they are hung, handle up, carapace out, from wall nails; they are not wrapped or covered. In the longhouse, great turtle rattles not in use are often hung high above the benches on the west wall. When placed on the benches or on the sills, the carapace side is up. As one informant explained, "You never see a turtle on his back, do you?"

Great turtle rattles are used by two groups: (1) the musicians who play for the great Feather Dance,[11] and (2) the False Faces,[12] *kakŏhsa?*. Great Feather Dances were held on the third, sixth and seventh days of the 1952 Midwinter rites, and members of the False Face Company appeared on the first and fifth days. In all, the great turtle rattle was in use on ten occasions during five days of the longhouse New Year's activities. Substitutes for the great turtle rattle are often carried by the Common Faces. However, only those substitutes described in the next section are used in this manner—other instruments such as the water drum or horn rattle are never so employed.

In describing the techniques of playing the great turtle rattle and other Seneca rattles, the following descriptive terms for different types of rattle noises will be used:

1. Roll: The sound produced by the uninterrupted rolling about of the pellets against the interior surface of the receptacle.
   1*a*. Scrape-roll: The sound produced when the receptacle is rubbed against a hard surface. The sound of the pellets predominates over that of the scrape.
2. Snap: The sound produced when all the pellets hit simultaneously against one wall of the receptacle as a result of abruptly terminating a single stroke of the rattle. There is necessarily a preceding roll.

[9] Small replicas of great turtle rattles and folded bark rattles are made occasionally as "souvenirs." No religious, ritual, or charm significance, however, was attributed to any of these by our informants.

[10] Other dimensions averaged as follows: length of head below the grip, 2½″; maximum height of carapace arch, ½″ to ⅝″ greater than the center thickness of the receptacle (average, 1⅞″); length of exposed parts of top splints, 2⅛″; length of exposed part of bottom splint, 2½″; width of splints, ½″.

[11] One of the "Four Sacred Ceremonies," Fenton, 1936: 13; Kurath, 1951: 125.

[12] Fenton, 1941*a*.

*2a.* Contact-snap: The sound produced when the stroke is stopped on a relatively non-resonant body such as the hand or thigh. The sound of the pellets predominates over that of the external contact.

3. Crash: The sound produced by the percussion of the receptacle against a hard object such as a bench or the floor, resulting in a sharp noise amplified by both the receptacle and the other object as resonators. The sound of the receptacle hitting against the hard object predominates over that of the pellets. There is necessarily an accompanying snap.

More types of rattle noises (roll, scrape-roll, non-contact-snap, and crash) are made in using the great turtle rattle than in playing any other Seneca idiophone. The crash, typical of Great Feather Dance rattling, and the scrape roll, used only by the False Faces, are sounds rarely produced elsewhere (*cf.* horn rattle, below).

The wooden False Faces carry great turtle rattles in their hands or hanging from their wrists. A single individual never uses more than one rattle at a time; this is true of all Seneca sound instruments.[13] During tobacco invocations and during rites the Faces may roll and snap their rattles or produce a scrape-roll.[14] Simple rolling and snapping are more often produced while the faces remain in a more or less erect posture or while they are walking. On entering and leaving the longhouse, however, they usually scrape-roll the rattle by rubbing it against the door rapidly. Inside the longhouse, while moving about in a crouched position or while kneeling on one knee in front of a longhouse stove, the faces intermittently grate their rattles back and forth in 10″ or 12″ arcs across the floor. In this type of scrape-rolling, the plastron side of the rattle is always down, i.e., toward the rubbed surface, although the only parts of the receptacle coming into direct contact with that surface are the ventral sides of the lateral marginal shields (adjacent to the bridge) of the carapace. Shaking the great turtle rattle in this manner differs significantly from other rattling techniques used at Coldspring. These other techniques furnish rhythmic accompaniment for singing, dancing, or both. Scrape-rolling does not. While the Faces agitate their rattles in this fashion, an unmasked longhouse elder may intone a short invocation, but there is no musical connection between the two acts. Similarly, the occasional vocalization produced by the Faces is non-musical. Inasmuch as scrape-rolling requires no vigorous, prolonged, or unsupported shaking, rattles carried by Faces for this purpose are frequently of maximum dimensions (18″ or 20″ in total length, etc.).

For the more secular individual dances of the Common or Beggar Faces, the Seneca prefer smaller rattles. In accompanying such dances the rattler vigorously bangs the turtle shell receptacle sideways on the floor or against the edge or back of a longhouse bench. When a Beggar Face wishes to dance, he first persuades someone in the audience to accompany him. He hands his rattle to the chosen individual who beats out a fast, crashing, duple rhythm, beginning with a simple roll or scrape-roll. The rattler usually sings at the same time, although this is optional. The individual songs seldom last more than forty-five seconds during most of which the rattler maintains a steady, trochaic (loud-soft, loud-soft) beat. He usually holds the rattle in only one hand, and if he plays it at his side the plastron is kept toward his body.

Several Face-singer pairs often perform simultaneously, creating a great din and resulting in a high degree of hilarity and enjoyment for spectators and actors alike. Disorganization (Faces do not dance in unison), fun-making, mimicry, and fancy foot work are all in order.[15] For this type of dance performance, the individual False Faces are given some form of tobacco, often cigarettes.

From time to time, the Faces make weird, high-pitched, quavering, vowel sounds.[16] They do not sing, however, and they do not use "their language" while engaged in strenuous dancing.

Beggar Faces are usually young men or girls; Curing, Doctor, or Doorkeeper Faces are men, and only men are chosen to use a rattle in accompanying a False Face dance.

The most impressive—as well as the loudest and most fatiguing—use to which any Seneca instrument is put is undoubtedly the fast, rhythmic concussion of the great turtle rattle on the longhouse bench during Great Feather Dances. Six times during the 1952 Midwinter doings this dance was performed; only once in costume (on the sixth

[13] W. N. Fenton adds (in a personal communication), "At the peak of his career, the late Chauncey Johnny John who was often alone when singing Great Feather Dance sometimes held a great turtle rattle in each hand, crashing them together on the bench. He was a singer!"

[14] For a discussion of Iroquois False Face types, rites, and functions, see Fenton, 1941*a*.

[15] Good descriptions of this type of dancing may be found in Fenton, 1941*a*, and in Kurath, 1951.

[16] Aptly described as "peculiar whinnying noises" by Speck (1949*b*: 93).

day). No other singing tools were used on these occasions; no substitutes were employed.

On days when the Great Feather Dance occurs, one of the faithkeepers puts two rattles, carapace up, on a backless wooden bench placed in the center of the longhouse between the two stoves. The rattles may belong to the longhouse, or to any individual in the community. Usually arrangement for procuring the two required rattles is made beforehand, so that the owners or keepers will bring them when needed.

When one of the officials announces the Great Feather Dance he also names the musicians. On occasion, one man "who knows how" may have to do the singing and rattling by himself (e.g., on the seventh day, 1952 New Years), but usually there are two musicians. Removing their caps, they sit down facing each other straddling the center section of the bench. Enough space is left between them so that they are a foot-and-a-half to two feet apart (knee to knee). They test the rattles for a few seconds, sometimes exchanging them to suit their individual preferences as to size, weight, and grip. Then, grasping the handle firmly, with both hands—the left usually somewhat more advanced (over the right) and closer to the shell—each musician commences to beat out a steady, simple, duple rhythm crashing the edge of the receptacle on the bench between his legs and about even with his knees, so that the tip of the rattle extends only a few inches beyond. In each section, antiphonal calls mark the beginning and follow the last rattle beat. The two rattles are played no more than a foot apart, tip to tip; they are usually both in line with each other near the center of the longitudinal axis of the bench top.

At first the two rattlers may not be in time with each other, but they soon adjust their strokes accordingly and thereafter maintain a perfect unison of beat throughout the performance. Average strokes move the striking edge of the rattle in four to five inch arcs. During more emphatic phases of the dance, these sweeps may be heightened to twelve inches with a correspondingly louder concussion. The legs from the knees down and the upper arms are kept usually in a vertical position. The arms are held in close, deriving as much support from the body and thighs as possible.

The first section of the Great Feather Dance is sung by the two musicians to a simple duple crash. Dancing starts with the third song when the rhythm shifts to a louder, more rapid, and basically iambic (soft-loud, soft-loud), duple crash. The rapid, continuous, and thunderous impact of the turtle carapaces on the wooden bench literally drowns out most other sounds, including the voices of the singers and the striking of the pellets against the roofs of the receptacles. Rhythmic pandemonium breaks loose. The whole longhouse seems to shake as the heels of twenty-five dancers resound on the wooden floor to each accented blow of the rattles. Very few other longhouse dances demand such physical vigor and stamina on the part of both dancers and musicians.

Each section, usually lasting less than a minute, ends abruptly with the simultaneous cessation of rattle crashing, singing, and dancing. No discernible signal, such as a change of rattle tempo, precedes such stops. After a few seconds, the iambic banging is resumed and the dancing continues. A single performance of the Great Feather Dance lasts from six to twenty minutes (1952 Midwinter, average: twelve minutes; number of dancers ranged from fourteen to thirty). Simple duple rhythms are occasionally repeated, and short embellishments such as the alternation between rattling and singing occur at different times. If the rattler removes his left hand for a few beats, a non-contact-snap results in place of the softer of the two crashes. When the last section has been sung, all activity stops, the head singer strikes his rattle twice, and the dancers and musicians return to their seats along the sides of the longhouse, leaving the rattles as at the beginning to be removed later by one of the officials.

The distinctive, iambic beat of Great Feather Dance rattling was not observed during any other longhouse activity. Aside from being distinctive, however, it is most impelling. During idle periods in the longhouse and elsewhere, even small children were observed banging sticks on bench tops in this fashion.

During the Great Feather Dance the musicians often exhibit signs of physical exertion not associated with other types of longhouse music. They keep time optionally with one or both feet, pounding their heels (never their toes) on the board floor with each loud crash of the rattle. During more excited phases the rattler holds the rattle in a vice-like grip, closes his eyes, and while singing and playing he gives his last ounce of strength to bouncing both feet several inches off the floor with each major crash. Many spectators keep time with their heels, too. Despite the January or February weather, the fires in the two longhouse stoves are allowed to die down before the dance begins. Mu-

sicians and dancers peel off outer garments and soon request that at least one door of the longhouse be opened to compensate for the rapidly mounting room temperature. For several days, a musician's throat, wrists, and biceps will remind him that he has sung and played for the Great Feather Dance.

For the best results and longest use of a great turtle rattle under these circumstances, the musician holds the rattle so that when contact is made, the flattest and straightest portion of the lateral edge of the carapace is parallel with the bench top. The plastron side is usually kept to the player's right and slightly turned under, i.e., forming a 65° to 70° angle with the bench top. In addition, the rattle is sometimes oriented so that the distal end swings about 20° to the right (as seen from the top). The early cracking of the lateral scutes and bridges of a turtle rattle is most often attributed to the user's faulty grip together with over-reckless pounding.

In order to make turtle rattles last longer, some of the Coldspring people (Lindsey Dowdy says he was taught by his grandfather, also of Coldspring) wet the banging side of the rattle the night before the Great Feather Dance. This overnight soaking in a pan filled with an inch or so of water is believed to soften the edge parts enough to prevent cracking, chipping, or flaking the next day.

Great Feather Dance rattling quickly wears through the top board of the backless wooden bench. For this reason, the bench top consists of three sections, the middle one being replaceable. Formerly (fifty years ago?), according to several informants, a deerhide was placed over the center of the bench to save turtle shell and wood, but none is used today. As a result, even before the dancing began we could see two well-hollowed depressions near the center of the bench. During the height of the costumed Great Feather Dance on the sixth day, the middle section, which is said to wear out every five or ten years, broke into three pieces lengthwise. The center piece had split apart from the sides and collapsed when the rattle-worn concavities in the originally one-inch pine stock reached a depth of more than ¾". The dance proceeded as if nothing had happened, however, each rattler using the remaining side strip to his left. The entire bench top measures 12′ × 14″, the replaceable center section being 3½′ long. Side boards come down from the top for 5½″, and the total height of the bench, supported by three solid, vertical, 12″-wide boards, is 20″.

Great Feather Dance singing is the hardest there is. Often two musicians "switch off," each singing part of each section in order to give the other a rest. Even with two men singing together, however, the accompanying din is so great that from a position only ten or twelve feet away their voices are inaudible during most of the dancing.

The ritual significance of the Great Feather Dance as a thanksgiving ceremony, the sanctioned participation of both sexes—young and old—in the dance itself, as well as the choreographic and melodic patterns involved, have been described elsewhere.[17]

The way turtle rattles are used by Great Feather Dance musicians is obviously quite different from the manner in which they are employed most often by the False Faces. With the former, playing requires a special property—the bench—and is always rhythmical. The two rattlers keep together and the accompanying dancing is carried out in perfect time. The most recurrent rhythmic motif is iambic, and in playing, the rattle is never struck perpendicularly across the edge of a bench, but rather lengthwise, on the top. False Face usages contrast at most of these points and, in addition, frequently involve substitutes such as the tempo beater and tin rattle (discussed below) which the Coldspring people never use for Great Feather Dance.

As with manufacture, the playing of a great turtle rattle involves specialization in the longhouse community, though not necessarily by the same individuals. Ed Curry makes rattles; Herb Dowdy and his father Lindsey are recognized experts when it comes to playing them. They take great pride in their ability, and are more careful with turtle dance rattles than are non-users. It is most impressive to observe the kinesthetic pleasure which such specialists derive from the physical exertion involved in skillful playing for the Great Feather Dance.

## SUBSTITUTES FOR THE GREAT TURTLE RATTLE

Four Coldspring longhouse instruments are discussed here. Three of them (bark rattle, tin rattle, tempo beater) are used in the same manner as the great turtle rattles of the Common or Beg-

[17] Morgan, 1901: **1**: 268–272; Kurath, 1951: 25f.; Fenton, 1942*a*: 11–14; Fenton, 1942*b*; see also Cornplanter, 1938: 217.

gar False Faces. The tempo beater is also used in the absence of a horn rattle or water drum. The first two are more restricted and are never substituted for horn rattles or drums. The fourth instrument here discussed, the wooden turtle rattle, is used as a practice dummy for those who are learning to accompany the Great Feather Dance. Rarely, it is employed during an actual performance of the Great Feather Dance when there are no genuine turtle rattles available.

Of the four instruments, the one-piece tempo beaters and wooden turtle rattles are the simplest and most temporary. Tin rattles are slightly more complex in form, and last somewhat longer. Bark rattles are as durable as any of the principal Seneca singing tools. During the 1952 Midwinter Festival, we observed tempo beaters and tin rattles in use in the longhouse. Bark rattles were examined in homes outside the longhouse. Our notes on wooden turtle rattles rest on informants' description alone; none were seen.

### BARK RATTLE

The *osnó·ʾ kastáwēʾshæʾ*, literally 'bark rattle,' is a simple instrument made from a single piece of green hickory bark (fig. 3, A, B). It is carried by the False Faces and is in every way substitutable for the Faces' use of the great turtle rattle. In fact, some Coldspring people call this kind of sound instrument *osnó·ʾ káʾno·waʾ*, 'bark turtle'; or simply *káʾno·waʾ*.

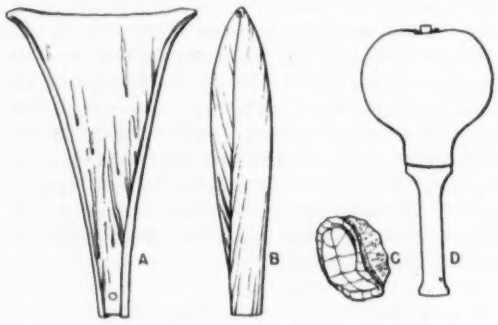


FIG. 3. Three types of Seneca rattles; about ½ actual size: A, hickory bark rattle (front view); B, hickory bark rattle (side view of A); C, box turtle rattle; D, big gourd rattle. For photographs of bark rattles, see Fenton, 1941*a*: pl. 23; Lyford, 1945: illus. 35; Morris, 1914: facing p. 162; Speck, 1945: 78; of box turtle rattles, see Speck, 1945: 79; Speck, 1949*b*: pl. 14, *d*; of big gourd rattles, see Morris, 1914: facing p. 162; Parker, 1912: pl. 21; Speck, 1945: 78, 79; Speck, 1949*b*: pl. 15, *e*.

Although we did not see bark rattles used in the longhouse, we saw one played in a nearby house and examined half a dozen others in the Coldspring area. Ten or more years ago they were more common—reportedly as numerous as great turtle rattles—than at present.

Fenton reports a tradition that the great turtle rattle is a later invention than the bark rattle. His informant believed that there were bark prototypes for many items now made of wood and other materials.[17a]

Construction of bark rattles is relatively simple and a maker often turns out as many as a dozen at one time. Richard Johnny John and Aaron Jacobs are known to make good bark rattles at Coldspring. They say that they can make one in twenty minutes if they are in a hurry.

Basically, the bark rattle consists of four parts: (1) bark shell, (2) handle plug, (3) pellets, and (4) hanging string. No tools other than a hatchet and a jackknife are required in making this type of rattle.

After cutting down a hickory sapling 3″ to 4″ in diameter, the rattle maker circles the bark with a knife incision at two points separated from each other by a distance equal to approximately twice the desired length of the finished rattle. This means that about 25″ of clean bark (without branches or deep gashes) are needed to make one good-sized rattle. Hickory for this purpose is cut in late spring or early summer so that there is still enough sap to prevent the bark from sticking. After the two ring incisions are made, they are connected by a single, longitudinal knife slit which also cuts through both the outer and inner bark. The maker then removes the entire bark cylinder with his fingers, and—by inserting his thumbs—immediately folds it over end to end, straightening out the natural curl of the bark in the middle section. The inner bark is left intact so as to make this bending and subsequent shaping easier; and to make any future reworking possible (by moistening). The outer bark alone would be too dry to handle in this fashion.

In folding the bark strip, the curled ends are placed one within the other, the outer curl usually being the lower end of the strip (as it was on the tree) and hence slightly thicker (see bottom of fig. 3, a). In this way the narrowed, curled ends form a cylindrical grip at least two bark layers thick, the inside of the bark forms the interior sur-

[17a] Fenton and Dodge, 1949: 13–14, quoting the late Chauncey Johnny John of Coldspring.

face of the rattle, and only the tough outer bark is exposed. While still moist and pliable the bark is easily molded and bent into shape with the hands. Nevertheless, if the maker wants to fashion a particularly large rattle, or if the bark he is using is very thick, he may have to do some trimming so that the curled-over ends will fit around each other neatly and will not form too thick a handle to grip. As a result, the middle width of a tapered strip (if flattened out) may measure more than two and a half times the width of the same strip at either end. The rattle maker does such trimming by making diagonal knife cuts which are kept straight and roughly symmetrical, starting at the opposite margins of the strip at the middle and drawing them in toward both ends at an angle of at least five degrees. Trial and error cutting, and shaping with the hands, are the only techniques involved.

When the desired form has been achieved (fig. 3, A, B) and the ends are even, the whole bark shell is bounded tightly with bast, leather, copper wire, thread, or string, to hold the curled bark in shape until it dries. A handful of pellets—preferably choke-cherry pits, but sometimes quartz pebbles up to the size of a "robin's egg"—are thrown inside for percussion, and the tubular handle end is plugged with a piece of wood whittled down from the discarded hickory pole, a corn cob, a tight roll of newspaper, or an egg-shaped stone. The maker inserts this plug for 3″ or 4″ to keep the grip part of the rattle from collapsing, and to prevent the pellets from lodging in the bottom of the receptacle interior or from dropping out. The lower end of the plug is usually made flush with the base of the bark shell, but it is sometimes left extending several inches below. When this is done, a hole through that part serves as the means of attachment for a hanging string. Otherwise, a hole for this purpose must be bored or burned through the base of the handle, i.e., through the bark layers and the plug, usually from front to back (fig. 3, A). An alternate method is to attach a string by means of an encircling groove, cut around the outside bark layer about an inch from the base.

Lack of cherry pits or "ambition" may delay the finishing of a bark rattle for months. In such cases, the dried out bark shell is softened enough for inserting the pellets and plug by soaking the base in a glass of water overnight. Varnish or shellac is sometimes applied after washing the bark with water. Makers occasionally incise their initials near the top. Rarely, little designs ("wigwams," "hatchets," etc.) are burned in the back surface of a bark rattle. No examples of this type of decoration were seen and local bark-rattle makers said they usually left their plain.

If the bark is too dry or too thick when bent, it will crack open at the bend and in longitudinal fissures which may enlarge, curling inward, allowing the pellets to escape and rendering the rattle useless. Therefore care is exercised in getting the bark in June, if possible; in shaping it into rattle form as soon as possible; and in avoiding the use of thick bark.

The bark rattles we examined ranged from 8″ to 14½″ in total length, and from 3″ to 9″ in maximum width at the top (middle of bark strip). Other measurements were: maximum thickness (from front to back), 1½″ to 2¾″; diameter of plug, ¾″ to 1¼″; width of upper end of bark strip, 1⅛″ to 3⅛″; and width of lower end of bark strip, 2¼″ to 4″.

So long as a bark rattle is not put in a moist place, it will not lose its shape and little damage can be done to it. Such rattles are thrown in a bag like horn rattles, and "put in the corner"; hung up by the cord attachment; or are simply placed on shelves or house rafters. Well made bark rattles are perhaps the most durable of all Seneca instruments.

As indicated above, bark rattles are used by False Faces and their accompanyists, in the same manner as great turtle rattles; shaken with the front surface on the bottom, top, or to the side, for snapping, scrape-rolling, and crashing respectively. Bark rattles are not used for the Great Feather Dance.

### TIN RATTLE

The tin rattle, called *káistatkos kastáwē⁹shæ⁹*, 'tin (or cup) rattle,' or simply *kastáwē⁹shæ⁹*, is carried by Beggar Faces when they are unable to obtain a Great Turtle Rattle. Two were used in the 1952 Midwinter rites. The instrument is fashioned in a few minutes by the young person of either sex who needs it. A baking powder can, large sized condensed milk can, or any double-ended can of about this size, with the label removed, forms the receptacle. A round or square hole is punched in the center of each end of the can to receive the 8″ to 15″ handle which is roughly whittled from any available stick. The handle may have a shoulder to support the bottom of the can, or a nail may be driven through the stick for

this purpose. Another nail through the distal tip of the handle which projects ½" or so beyond the can prevents the receptacle from sliding off. Sometimes the handle is squared off where it passes through the proximal end of the can, and the section below this point swells slightly, so that no bottom pin is required. Occasionally a discoidal shoulder serves this function. The pellets are pebbles or corn kernels, preferably the former. There is no hanging string, and no special methods of storage are observed. These instruments are short-lived, not carefully constructed, and ordinarily made anew each time they are required.

Despite the general similarity of appearance and construction between the tin rattle and the horn rattle (see below, pp. 280–281), it is only the Beggar Faces' great turtle rattle for which the tin rattle may be substituted, and the method of using the latter strictly follows that of the former. The Face uses a tin rattle to produce scrape-rolls, rolls, and snaps, and dances to the crashes produced when his accompanyist bangs the instrument against the floor or the edge or back of a bench. The contact-snaps typical of the use of the horn rattle are never produced with the tin rattle. Since these instruments are not sturdy, they frequently break while in use. In such a case the accompanyist continues, using the rattle handle as a tempo beater.

### TEMPO BEATER

A simple wooden rod, called *ka²nhyá²* or *ka²wásta²*, 'stick,' is another frequent substitute for the great turtle rattle of the Beggar Faces. The Face wearer roughs out a stick some six inches to a foot long and an inch or two in diameter from a bit of firewood or a branch with the bark left on. The ends are left ragged, and no particular effort is taken with the construction. These sticks are used in the same manner as the Beggar Faces' great turtle rattles or tin rattles—even to imitating the scrape-roll which of course results in simple scraping sounds without rolls. The tempo beater is not damaged if an accompanyist keeps time for a dancing Beggar Face by knocking the stick against the top of the iron longhouse stove, a method not observed in the use of turtle rattles or tin rattles.

During the 1952 ceremonies three or four tempo beaters were used in the longhouse by Beggar Faces. Informants mentioned the banging of similar "common sticks" against the musicians' bench as substitutes for the horn rattles required for such dances as the Traditional Women's Dance or the Fish Dance. However, the lack of horn rattles is a condition hard to imagine in the present Allegany community.

### WOODEN TURTLE RATTLE

Fenton [18] mentions "elaborately carved wooden turtles that have been hollowed to house noisy pebbles," used as great turtle rattle substitutes by members of the False Face Company. We heard of no such carefully constructed imitations at Allegany, but were told that at the Green Corn Festival in the summer of 1951 when a turtle rattle was needed for the Great Feather Dance and none could be "borrowed," a substitute was rapidly whittled out of a board. This was a solid piece of wood copying the general shape of the great turtle rattle, some nine or ten inches long. After being used this one time it was tossed into the longhouse cookhouse, where it could not be found for examination during our visit. Similar rough wooden models of turtle rattles are said to be used occasionally by those learning to sing and play for the Great Feather Dance.

### WATER DRUM

The instrument most often heard at Seneca doings is the water drum. Together with the horn rattle, it furnishes the typical accompaniment for social dances and many rituals. For at least two rites, the dances of the Bear and Buffalo Societies, it is the only singing tool employed. The water drum used at the Feast of the Dead is somewhat larger than the common dance drum and will be discussed separately. No other drum types are used at Coldspring.

The Seneca call this little water drum *ka²nõhko·wõ*, or *kanõ²tso·wa*, the latter term referring more specifically to the "pail," or wooden base, over which the drumhead is stretched. In local English, "Indian drum" and "little drum" are more frequently heard than "water drum." The carved wooden beater is called *yei²nõhkwa²éstha²*, 'drumstick.'

Any man at Allegany can make a water drum if he wishes, although in practice very few do so. Avery Jimmerson, Ed Curry, and Arthur Johnny John are among the locally known craftsmen who make drums. They possess the needed tools, such as "curved knives" (crooked knives), chisels, braces and bits, and adzes. They are not crafts-

[18] Fenton, 1941*a*: 425.

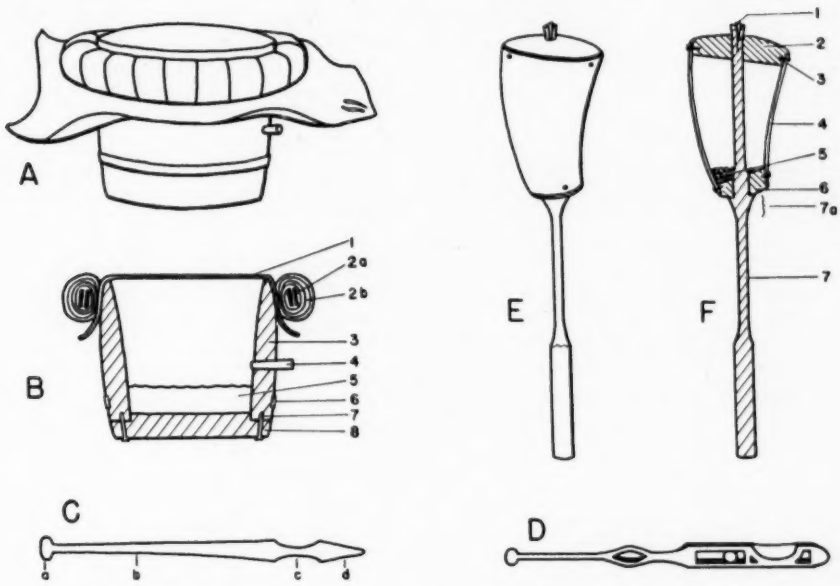


FIG. 4. Water drum and horn rattle; one-fourth actual size: A water drum, B cross-section view of water drum, C cross-section view of a simple water drum stick, D carved water drum stick with wooden "marble"; E horn rattle, F cross-section of horn rattle. B: 1, drumhead; 2, tightening hoop (*2a*, wooden ring; *2b*, cloth wrapping); 3, body wall; 4, bung; 5, water; 6, binding band; 7, nail; 8, body bottom. C: plain drum stick (*a*, head; *b*, shaft; *c*, grip; *d*, foot). F: 1, wedge; 2, top plug; 3, nail or peg; 4, horn receptacle; 5, pellets; 6, bottom plug; 7, handle (*7a*, shoulder). For photographs of water drums, see Dodge, 1949: 69; Fenton, 1942*a*: pl. 4, 6; Fenton, 1953; Lyford, 1945: illus. 33; Morris, 1914: facing p. 162; Speck, 1945: frontispiece; Speck, 1949*b*: pl. 14, *c*; of horn rattles, see Dodge, 1949: 69; Fenton, 1942*a*: pl. 4; Fenton, 1953; Lyford, 1945: illus. 34; Morris, 1914: facing p. 162; Speck, 1945: 78, 81; Speck, 1949*b*: pl. 15, *a*.

men in a commercial sense, however, since they make drums only for their own use, or when one is needed in the community. A maker may ask $5.00 for a drum body, $10.00 for a finished water drum, complete with hoop and drumhead; he may loan it freely, or give it to a friend who needs it. Our information on manufacture was obtained mostly from the drum makers mentioned above. For notes on the use of the water drum, we rely more heavily on our observations in the longhouse and discussions with such leading singers as Albert Jones and Herb Dowdy.

Basically, a Seneca water drum is a small wooden [19] vessel over which a piece of soft-tanned hide is stretched by means of a cloth-wrapped wooden hoop. The drumhead is kept wet with water contained in the vessel, and the drum is beaten with a carved wooden stick. For the purposes of this description, the water drum can be said to consist of the following five parts (fig. 4, B): (1) a wooden body, which may be simple, i.e., one-piece; or complex, with or without a binding band, with a separate bottom which is usually nailed to the one-piece or stave sides or walls of the body (fig. 4, B); (2) bung; (3) drumhead; (4) tightening hoop, consisting of an inner wooden ring and an outer wrapping; and (5) water. Drumsticks (fig. 4, C) are discussed in terms of their component features: (*a*) head, (*b*) shaft, (*c*) grip, and (*d*) foot.

Simple drum bodies and the one-piece walls of complex vessels, are best made from the heart wood of tough tree trunks such as those of the willow, *Salix* sp., and pepperidge, *Nyssa sylvatica*, Marsh. The latter is especially good for drum bodies because the grain goes "every which way" and prevents splitting even after a long period of

[19] The Allegany Seneca do not use iron kettles, pottery vessels, glass jars, or other nonwooden containers for drum bodies. *Cf.* Voegelin, 1942: 471, 473.

seasoning. Bodies of pepperidge and willow do not require binding rings. The heartwood of softer trees such as basswood, *Tilia americana*, Linn., and cucumber, *Magnolia acuminata*, Linn., is easier to work and is often used for this reason, although some type of band must be applied to keep it from splitting. To prevent excessive "checking" while drying, the exposed ends of drum wood logs of these softer woods are rubbed with lard or grease. Several informants said that drum wood should be cut before the first spring thunder, which "shakes the timber" and causes it to crack.

Separate bottoms are most often made from hickory. Stave-walled bodies are frequently made by cutting down paint or nail kegs. In making solid-walled or one-piece bodies, the maker whittles down the outer bark and sapwood from a section of a well-dried log which has already been cut to the right length. When the desired diameter is attained, the maker starts drilling and gouging from one end. Formerly the interior was hollowed out by burning; now, braces and bit and other metal tools are more commonly used.

Except at the very top, the outer circumference of Allegany drum bodies either remains constant or decreases slightly toward the base, the maximum diameter being about 1" or so down from the rim. On other Iroquois reservations, including Six Nations in Canada, the greatest width is at the bottom, the walls sloping in from the base to the rim. In either case the walls thicken toward the bottom and become thinner at the rim. The outer rim edges are always slightly rounded, to avoid damaging the drumhead. One-piece drum bodies are taller than complex bases because of the greater thickness of the bottom (up to 2"). The dimensions of the hollow interiors, however, are very similar.

Viewed from the top, Allegany water drums are round in cross section. Single piece bodies were formerly flat *or* round bottomed; today all drum bodies are flat bottomed, although one-piece log vessels are sometimes slightly convex across the base.

If a separate bottom piece is made, it is flanged to fit tightly into the body cylinder as shown in the diagram (fig. 4, B, 8), and six or eight nails are driven through from the base into the walls (fig. 4, B, 7). A riveted metal band (common) or a knotted cord of twisted bast (not seen) is placed as a binding right around the lower part of most drum bodies (fig. 4, B, 6). The maker sometimes carves a shallow groove into which this band fits.

Half way between the rim and the wall bottom, a ¼" to ¾" hole is bored straight through into the body interior, and a small hardwood plug—usually of hickory—is whittled as a bung. This plug is 1½" to 2" long, somewhat larger at the outside end, and is usually not carved or knobbed in any special manner.

In each case, the plotted heights and diameters of both the interiors and exteriors of the three water drum bodies measured—using maximum dimensions—come to within ¾" of being square. There is a slight preference, often accentuated by the presence of the tightening hoop, for greater drum width over drum height. The average volume of the water drum interiors is 30 cubic inches; the figures used ranging from 2¾" to 3¼" in depth, 3¼" to nearly 4" in width. Other averages of measurements made on water drum bodies are: total height, 4½"; maximum diameter, 4¾"; base (bottom) diameter, 4⅛"; wall thickness at the bottom, ¾", and near the top, ⅜"; thickness of the bottom, 1¼"; maximum rim-to-rim diameter, 4⅜"; width of binding ring, ½". These figures refer to solid-walled bodies only; keg walls are not greatly modified except for the rounding of the outer rim edges.

Usually, no decorative elements are added to the drum body although both inside and out are frequently given a protective coat of paint (dull red being a favorite color). The only carving noted was on the sides of Avery Jimmerson's basswood water drum. He had gouged out eleven, parallel, vertical grooves—about an inch and a quarter apart—all around the solid-walled body, from the bottom to within an inch of the rim. In talking about wooden kegs for water drums, Avery told us that he had incised these "cracks" in his one-piece drum, "to make it look like a real one"! This is an interesting example of a *reverse* skeuomorph [20] and a possible explanation for its occurrence.

For a tightening hoop, a drum maker thins down a long hickory strip on his shave horse until it is uniformly about ½" by ⅛" through, and at least twice as long as the circumference of the body rim. He then coils the strip around on itself, tapering the ends so that an even overlap results

[20] If a skeuomorph is defined as an object made of new materials but following the old form (see Sayce, 1933 81–90), then an object made in the old way but following a newer form may be called a reverse skeuomorph.

on the inner and outer surfaces of the ring. Tying this in place temporarily, he cuts opposite, transverse notches every 2" to 4" along the top and bottom edges of the ring. Using these grooves, he then binds the ring with ties of twisted hickory inner bark string, common cord, or fine copper wire. Some drum makers are less meticulous in these matters, but a careful craftsman goes even further, seeing to it that the knots or wire twists of these ties are all tucked in on the lower side, so that when the hoop is banged in tightening (see below), the rough or sharp ends will not tear through the cloth wrapping.

Around this wooden ring the maker wraps ½" to 1" wide strips of cotton cloth, usually from old clothing. In this way the hoop is enlarged, and is made to fit very snugly around the wooden body and skin drumhead (fig. 4, B, 2a, 2b). Additional strips may be added as the old wrapping wears down. Old hoops may become very thick; one measured 1⅛" × ⅞" in cross section. In applying a cloth strip, the loose end is wrapped up and around on the outside of the hoop, and down on the inside.

Woodchuck (*Marmota monax*, Linn.) skin, soft-tanned with poplar (*Populus* sp.) wood ashes makes the best water drum head. More commonly used today, however, are remnants of horsehide and cowhide torn from old leather jackets, boot vamps and tongues. A drum maker usually cuts the skin into a square or rectangular (rarely trapezoidal) shape, about two and a half times as long on the shortest side as the diameter of the drum body. A 10" square piece of hide is considered ample for a drum 4" across at the top. After the head is on the drum, two parallel slits are cut near one corner, about ½" apart (fig. 4, A). The drumstick is often stuck through these openings, under the center strip, when the water drum is not in use.

Drumsticks for beating the water drum average 8¼" in length and are carved from a single piece of wood (frequently ironwood, *Carpinus caroliniana*, Walt. (?), or hickory). In most other features drumsticks show more individual variation than any other item in the whole stock of Seneca singing tools. Heads, shafts, grips differ in shape, design, and proportions from one stick to another. The knobbed head (fig. 4, Ca) is carved in one of at least three ways: round (spherical, ovoid, or ellipsoid), square (oblong in cross section, or in the form of a truncated cone), and diamond (with a pointed tip and sloping base). The average maximum diameter of such heads is ½". Shafts (fig. 4, Cb) are carved in many forms. Some are gradually tapered back to the grip; others are bulged in the middle, rippled, squared, notched, or ornately decorated with other geometric carvings. Near the grip, and from the original billet, some carvers whittle a small "marble" which rolls back and forth in a four sided cage hollowed from the enlarged base of the shaft (fig. 4, D). Such an addition is merely a sign of the maker's ambition or of his desire to be "up to date," and is not carved for the slight rhythmic click it may produce. At the head end, all shafts are circular in cross section, and measure about ¼" or less in diameter. In total length they measure 2¼" to 4". The grip (fig. 4, Cc) is a double concave, usually symmetrical, thinning of the stick between the shaft and the foot. The pivotal center of this finger grip is never much thicker than ⅛", although widths—at this point—range from ½" to 1". The foot (fig. 4, Cd) is usually a tapered, less decorative butt, sloping back from the lower end of the grip. Shaft, grip, and foot are sometimes incised with simple geometric designs such as crosshatching.

We saw only four or five water drums at Coldspring, and only two were used in the longhouse for the 1952 New Year's doings. We were able to observe and examine many drumsticks, owing to the fact that a man who owns a single drum may have four or five different beaters.

A decade ago Allegany children used old glass jars, tin cans, and discarded rubber inner tubing for making toy drums. Instruments of this kind are no longer being made because the post war inner tubing "won't stretch." As stated before, Coldspring drums for ceremonial purposes are never made from such materials.

Before final assembly of a water drum, the loose skin drumhead is soaked until it is thoroughly wet. With about ½" of water in the drum interior, the head is then stretched across the open end of the body, centered, and clamped in place by setting the wrapped hoop down over the top on the outside (fig. 4, A, D). If the hoop fits too loosely, more cloth wrapping must be added. Going around the rim the musician grasps each corner of the drumhead, pulls it down as hard as he can (while it is wet), and—keeping it taut—pulls it out, up, and around the cloth-covered hoop. Without relaxing the tension on the skin margin, which is now stretched back across the body rim, the drummer takes a conveniently-sized (say 1¼" × 1¼" × 12"), smoothed wooden stick with which he

pounds on the hoop, driving it down a few sixteenths of an inch in each position, and drawing the head tighter with each blow. The added layer of skin, formed by the doubling back of the drumhead corners, shields the tightly drawn part of the head (the hoop-encircled surface, especially over the body rim edges) from the sharpness of these blows. After going once around the rim, the drummer tests the tautness of the head by tapping it with a beater. Tightening continues until the desired pitch is achieved. For weeks after it is tightened, the head remains sufficiently taut for good playing. It is rarely necessary to force the tightening hoop more than ¼" below the rim of the drum (fig. 4, A, B).

Water should be kept in water drums at all times. If they dry out, the staves of keg drums separate and collapse (a situation common to all museum specimens of this type), the solid-walled types tend to split, and the drumhead becomes brittle and loses most of its resonance. The amount of water in the drum and the wetness of the head are carefully regulated. Water is blown into the drum interior by the musician, through the bung hole at the side. When a drum is put away for some time, "four or five good mouthfuls" (equal to between a third and a half of the total volume of the drum interior) are considered sufficient to maintain the proper water table. Just before playing a water drum "one good mouthful" is added, and the drum is turned upside down for a few minutes for the head to become thoroughly saturated The bung (fig. 4, B, 4) is removed for only two purposes: (1) to insert more water, and (2) to "let the air out," i.e., to equalize the air pressure on both sides of the drumhead. The latter case is explained by the fact that when a drum is turned upside down the water soaking into and through the head leaves a partial vacuum inside. Greater air pressure on the outside forces the drumhead in, creating a concave exterior surface which appreciably lessens the tonal quality of the instrument. Hence, in contradiction to the local expression, removing the bung before singing actually lets some air *in*. While the drum is in use however, the bunghole is kept plugged to provide for maximum resonance.

The drum is kept inverted for a few minutes before singing commences and also during short rests between songs. Occasionally, a skilled musician will rewet the head by rapidly rotating the drum 180° and back without missing a beat (as in the introductory sections of the Thanksgiving Dance). During short pauses in the singing, while the drum is over-turned he may rub the head with his fingers in a circular motion to ensure equal saturation in all parts of the stretched skin. Or he may move the drum, still inverted, in a half-foot circle to achieve the same end. The wetter the head, the deeper the tone.

Drums are kept in warm rooms so that the water in them will not freeze. They are placed on their sides in bags with horn rattles, hung from wall nails, or set on shelves. No observed sacred elements are involved in the storage, care, or other treatment of drums. Children are not reprimanded for playing with them even in the longhouse. Once, at the 1952 New Year's doings, a water drum fell from a bench. There was no dancing going on at the moment, although many people were present. Nevertheless, no one bothered to pick it up for at least five minutes.

Drum bodies are best preserved if coated on both sides with paint or at least rubbed with tallow. This retards destructive fungus growth on the inside, especially near the rim. If the interior is not so treated the action of the water and fungus soon rots the body walls and the softened rim top must then be trimmed down about every six months. This can be done with the fingers. In one case we found that the rim walls of a four-year-old drum had already been cut down 1½".

To make drumheads last longer, they are often reversed, each time they are removed (which should be done whenever the drum gets dry) or retightened. There seems to be no preference for keeping either the smooth or rough side out, and no difference in tone is recognized. Because drumheads are always beaten "right in center" some drummers believe the reversal of skin surfaces should also be accompanied by a slight shift in the placement of the hide across the body rim. In making such changes, it is best to soak the whole drum skin first.

In general, water drums are less durable than other singing tools. Most drums seen at Allegany were made less than five years ago. Drumheads, drumsticks, tightening hoops, bungs, and binding rings can be repaired or replaced. Up to a point, the body itself can be trimmed, treated, and repaired. Its replacement, however, means a new drum.

As mentioned previously, the water drum is used more often than any other instrument at Coldspring, both in the longhouse and in individual homes. On all but a very few occasions it

is played with the cow horn rattle; never with any other singing tool. During the 1952 Midwinter Ceremonies, water drums (and horn rattles) were used from the third through the seventh day, for the Traditional Women's (Shuffle) Dance (third, fifth–seventh), Thanksgiving Dance (fourth, seventh), and Fish Dance (fifth, seventh). A water drum alone was played for the Bear Dance on the fifth day. In the first Seneca home (Abrams) to the west of the longhouse, an Eagle Dance and a Dark Dance were held on the fourth and sixth nights, respectively. Drums and rattles were used during each of these rites, and are played for a number of other doings (e.g., War Dance, Quavering and Changing-a-rib; various social dances) which did not occur during our visit.

In the longhouse, only one drum was used most of the time, though on the fifth day two were played simultaneously for both the Traditional Women's Dance and Fish Dance. One to three horn rattles were played together with the drums for dances other than the Thanksgiving Dance. The latter was accompanied by only one drummer and one rattler who, during the first performance (fourth day), sat opposite each other astride a bench. Drummers (and rattlers) for other ceremonies usually sat at the north end of a backed or backless bench, facing west. On several occasions another bench was put out parallel to the first and about 18″ from it. The musicians could then sit facing each other. At no time did a musician stand or walk while playing a drum.

In discussing the methods of playing the water drum the details of the numerous associated dances and rites can not be gone into at any length. In this regard, the recent works of Fenton, Kurath, and Speck furnish good background materials (see References). In general, drumming techniques and most forms of directly associated behavior are much the same from one dance to the next.

After sitting down, a drummer grasps the base of the drum body in his left hand, palm underneath; or, if the drumhead is large enough, he may hold the drum by grasping a bunched, outer corner of the skin between his left thumb and forefinger, the other fingers of his left hand supporting the body from below. He rests the back of his left hand or forearm on his left thigh so that the drum is usually partly over his left leg, partly over the space between his legs. He keeps his upper arm close to his body. The plane of the drum head is tilted as much as 40° to the right; it is not played in a horizontal position.

The drumstick is held at the grip between the thumb and the base of the index finger of the right hand. Techniques of beating vary, but this basic grip does not. While drumming, the main force of each beat comes with wrist rotation accentuated by secondary finger pressure. By the latter is meant the inward movement of the thumb which by itself would pivot the head end of the beater in a downward direction. Some drummers back up each heavy beat with a forearm stroke starting at the elbow. In any event, the arc traced by the head of a drumstick in an average, slow, but heavy, stroke ranges from about 8″ to 15″. With faster beats, this range is cut down by 5″ or 6″. Time is kept with the heel, or whole foot, for strong beats; with the heel alone for the lighter strokes. One or both feet (and/or heels) can be tapped. If only one is used, it is invariably the right, because the free right forearm does not rest on the right leg at any point. If both feet are used to stamp out the time together, the drummer must raise his drum hand several inches away from his left leg. Less energetic drummers rarely do this. Spectators keep time with their heels, too, as in every other rite accompanied with singing tools. Only during Personal Thanksgiving Chants do onlookers mark time with their toes, and during that ceremony—unaccompanied by any instrument—tempo marking practices vary more than at other times.

In beating the drum, the head of the stick hits the drumhead in the center, hardly ever falling outside a target area the size of a twenty-five cent piece. Each stroke, light or heavy, means a single, staccato beat; there are no rebounds or double bounces. The beater is never hit on or near the rim and only the knob head itself comes into contact with the skin drumhead. The last beat of a song, or a part thereof, is usually ended with a sharp raising of the stick to a point 6″ or more above the range of the stroke arc of the preceding section. A drummer never stops with his beater on or near the drum.

Most water drum rhythms are characterized by simple duple (slow or rapid, evenly accented beats) or trochaic (heavy-light, heavy-light) time. No iambic drumming was heard. Trochaic time is predominant in social dances, as is fast simple duple time in the Thanksgiving Dance and War Dance.

In the Thanksgiving Dance, sometimes called Drum Dance,[21] the first two songs are sung to a

[21] Fenton, 1948*a*, *b*.

slow, even, duple beat of both drum and rattle. The drummer faces the rattler to his north, both sitting astride a Great Feather Dance bench. About the middle of the third section (sections averaged 17 to 26 seconds in duration during the first [1952 Midwinter] performance) the tempo increases, dancing begins, and for a short period a double-accented, trochaic beat is heard. This soon changes into a rapid, even, but strongly accented, duple beat which predominates throughout the remaining sections.

Whenever drums and rattles are played together it is always the former that predominate; song leaders are invariably drummers. During brief rest periods between sections of longer songs, dancers often continue walking counterclockwise about the longhouse to the slow even notes of a lone water drum. Rattles join in only when the singing and dancing are about to be resumed.

In the longhouse or in other ceremonial situations, only men (or boys who are learning; e.g., Leeman Dowdy) play water drums. We were told, however, that a number of young and middle-aged women know how to sing men's songs and use their drums and rattles. Informally, at different homes, they occasionally display this knowledge for their own enjoyment.

For the water drum there are no standard, recognized substitutes such as exist for the great turtle rattle. Simple wooden tempo beaters may be temporarily employed to beat out a water drum rhythm, but such an occurrence is reportedly rare.

## HORN RATTLE

The third of the main instruments is called *kastáwẽ²shæ²*, 'rattle,' [22] or, when necessary to distinguish it from other 'rattles,' *onõ²kæ·² kas táwẽ²shæ²*, 'cowhorn rattle.' This is the rattle most often used to accompany singing and dancing, usually with the water drum.

Six or eight men in the longhouse community frequently make this instrument, and many others do so on occasion.[23] One Allegany maker charges other Seneca men fifty cents for making a rattle, if the horn is supplied by the orderer. A completed rattle is worth a dollar or so. In spite of this specialization, Albert Jones stated that he is unable to recognize the maker of an unknown specimen.[24]

The horn rattle (fig. 4) consists of a pellet-containing receptacle of horn mounted on a flanged wooden handle. The horn has a wooden plug nailed or pegged into the top, normally also a plug in the bottom, and is held tight against the flange of the handle by means of wedges or a pin in the projecting distal tip of the handle.

The receptable of the rattle is made from cow, steer, or bull horn. One example was seen which was made from bison horn. From a 12″ to 15″ long horn three or four receptacles can be made. Horns for this purpose are normally obtained by asking the owner of a dead cow for them. The maker first boils the entire horn to loosen the corneous part from the bone and to soften it sufficiently to be worked. The boiling lasts from fifteen to forty-five minutes. Both inner and outer surfaces are then scraped with a sharp knife or with a file. The outside is polished with sandpaper until the receptacle is from ⅛″ to less than 1/32″ thick. Variation in this thickness is said not to affect greatly the quality of the sound. Rattle receptacles are cut from the cow horn with a saw. The large ends of the resulting sections are always at the distal ends of the rattles.[25]

The plugs are normally made from hickory, although occasionally a scrap of wood from some piece of furniture may be re-used. In order to cut the plugs to the proper shape, the maker places each open end of the receptacle on the wood and draws a line around it. The pieces are then cut out and whittled down until they fit tightly into the ends of the receptacle. The most common form of plug has a small flange which fits over the edge of the horn (see fig. 4, F, 6), but sometimes the entire plug fits inside the horn without a flange. Both slightly convex and flat plugs are made. Occasionally the handle flange and the enlargement just below it are made sufficiently large to replace the bottom plug entirely. This method, although less common, is said to make assembly

[22] The earliest reference known to the authors where Iroquois rattles are called by this name is Lafitau, 1724: 215, where the term is given as *Astaouen*.

[23] The information given here on manufacture comes largely from the rattle makers Lindsey Dowdy and Ed Curry, and from Albert Jones, one of the main singers (and therefore owner and user of many rattles).

[24] According to W. N. Fenton (personal communication), "The rattles of Jas. Crow of Newtown, Chauncey Johnny John, and Jonas Snow were distinct and distinguishable by handle treatment. Tonawanda rattles, by several makers, in common have larger heads." See also Fenton, 1942a: 10 and pl. 4, 2.

[25] This orientation is constant for all types of Seneca rattles whose receptacles taper. This may be because a louder noise results when the large end, rather than the small one, travels through the maximum arc produced when the rattle is played.

easier and to increase the durability of the instrument. The plugs project about ⅛" to ⅜" into the horn, enough so that the nails will not split them.

The handle is whittled from hickory or maple. In cross section the base of the handle may be round or polygonal with four to ten facets. The handle may be straight, or waisted above a square-ended enlarged base as shown in fig. 4, F, or may consist of a thinner section swelling into a cigar-shaped base. Two informants agreed that the same maker uses various styles of handles. The flange and the sloping shoulder supporting it may be round or square in cross section, but the handle is always squared off where it passes through the rectangular hole in the bottom plug. This is done to prevent the receptacle from rotating on the handle when the rattle is in use. The distal end of the handle is round in cross section from the top of the bottom plug to the tip. After the plugs are fitted, the hole made in the bottom plug, and the handle roughly shaped, the top surface of the handle flange is whittled down until the distal end of the handle is long enough to project ⅜" or less beyond the top plug. A round hole is then made with the drill blade of a jackknife at the proper spot in the top plug, and the handle fitted through. The tip of the handle is either split for ½" to 1½" to receive small wooden wedges, or a hole for a pin is drilled through it almost flush with the top surface of the top plug.

At this stage the pellets are inserted. These consist of shot from a number four or number six shell, steel bearings, or occasionally pebbles. Choke-cherry seeds are never used. The sound is tested, holding the rattle together with the hands, until the right number of pellets is determined—usually about a dozen. The rattle is now ready to be permanently fastened together. If wedges are to be used, one to three wood splinters or matchsticks are forced into the split distal tip by knocking the distal end against a table top or other flat surface until the wedges are tight. Then they are trimmed flush with the tip. If a transverse hole has been bored, a short wooden pin, matchstick, ⅝" shoe nail, or commercial cotter pin is inserted. With worn or less carefully made specimens it is sometimes necessary to wrap the handle with string between the pin and the surface of the top plug, to prevent the receptacle from moving on the stick. The same maker may use either method of attaching receptacle to handle. Wedges are said to be easier to make, but a pin is preferable.

Fastening the plugs to the horn is the last step in assembly. For this, holes are made with a jackknife drill blade through the horn into the plugs to receive the nails or pegs. If the drilling were done at an earlier stage the horn would be more likely to split. The number of nails depends on the size of the horn—two to six in each plug are normal. If the bottom plug is replaced by the enlarged handle flange, no nails are needed. Some prefer ⅛" shoe nails but small ordinary nails will do. Wooden pegs were seen on one Allegany specimen made at the Tonawanda Seneca Reservation, but were said to dry and fall out.[26] At least one maker uses large round-headed shiny upholsterer's tacks, with or without ordinary nails in addition.

Finally the handle is smoothed by scraping it with a knife or a piece of glass, drawing the tool towards the maker's body. Further polishing is done with sandpaper, but a slippery finish makes it difficult to hold the instrument during playing; the Tonawanda specimen was criticized on this account as it was "too smooth." Once in a while the plugs are painted to retard cracking, but this is very rare. The maker, "if he's ambitious," may decorate the horn by burning in lines with a stiff, red-hot wire. One specimen at Allegany is decorated with the name "Frank Davy," the date "1922," two crossed pipes, and a "wigwam." Another has a date in "January 1910," burned in.

Measurements of a representative sample of some twenty-five to fifty horn rattles seen at Allegany show the following ranges in dimensions; the proportions of all follow closely those shown by fig. 4: overall length, from 9⅛" to 12½"; length of handle, from 5½" to 10"; largest diameter of horn, from 1¾" to 2½".[27]

A musician keeps his horn rattles in a bag with his water drum and drumsticks (if he has a drum), hanging from a nail on the wall. Those seen were deep rectangular cloth bags, with a drawstring or

[26] Fenton writes the authors, "Wooden pegs to hold the 'heads' in horn rattles at Tonawanda and wooden cotter pins to hold the handles in the heads 'came in' at Tonawanda with the WPA Arts and Crafts project 1935–37 during my residency. Cephas Hill and Jesse Cornplanter make them this way." The Tonawanda specimen referred to above is by Jesse Cornplanter.

[27] Other dimensions are: maximum length of horn, 2½" to 3¼"; largest diameter of proximal end of horn, 1¼" to 2¼"; length of enlarged bottom of handle (on the few specimens exhibiting this feature), 2¾" to 4½"; diameter of handle enlargement, ⅝" to ¾"; minimum diameter of handle bottom, ⅜" to ⅝"; diameter of handle flange, ½" to ⅞".

two cloth handles. Horn rattles are never hung up by a string (as are great turtle rattles and gourd rattles)—a man usually owns so many that a bag is the most convenient method of storage. It is recognized that for maximum preservation it is a good idea to keep the instruments out of reach of one's children, who may knock them about and whittle at the handles. Long life of horn rattles depends also on not using them often between ceremonies, and of course a favorite rattle gets more use. Those with thinner walled horn receptacles wear out sooner; one was seen with a hole worn in the horn, patched with cellophane tape. When the horn cracks, as it does occasionally, it may be bound together with friction tape. Sometimes it is necessary to replace a cracked top or bottom plug, and new wedges are required from time to time. Some nails or pegs are frequently lost. An old handle cannot be used with a new receptacle, owing to the varying shapes of horns. The durability of these rattles may be judged from the dated specimens in use at Allegany: the owner of the one dated 1922 estimates that it will last five or ten years longer; another one is dated 1910, and there is said to be still another at Allegany dated 1901.[28]

The horn rattle is used in all but four of the instrument-using ceremonies of the Midwinter Festival. The Feather Dance, False Face Beggars, Women's Rite, and Bear Dance are the exceptions; in addition, the Personal Chants and the Stomp Dance consist of singing without instrumental accompaniment. In most of these dances, the horn rattle accompanies the water drum; in the Pigeon Dance (not performed during the 1952 New Year's doings) and Corn Dance horn rattles alone are used—both of these are social dances. Typical dances use one water drum and one horn rattle, but up to three rattles in one dance (the Traditional Women's Dance) were seen in use, and even more are possible. In all cases where the horn rattle accompanies the water drum the drummer leads the singing. When rattles alone are used, one rattler leads the singing of all. There is almost always dancing during the playing of the horn rattle; in fact, starting to play this instrument normally serves as a signal for the resumption of dancing after the short walking breaks between song sections. In the Thanksgiving Dance there is a drum and rattle introduction of one or two minutes, before dancing commences.

There is apparently less specialization in the playing of the horn rattle than for either the drum or great turtle rattle. A greater number of different individuals were observed playing the horn rattle. The choice of player seems to rest largely on singing ability, not on dexterity in handling the rattle, which requires little special skill.

When a dance is about to begin, the players sit on a bench or sometimes two parallel benches in the center of the longhouse. For the Thanksgiving Dance the drummer and rattler sit facing each other astride the center of a backless bench.[29] Otherwise the players both sit facing one long wall of the longhouse. Each removes his cap or hat and places it behind him for the Great Feather Dance or Thanksgiving Dance, or beside him on the side towards the end of the bench. Rarely a cap is placed over the left knee, visor towards the body. Before taking his position the rattler tests the two or three horn rattles already placed on the bench and chooses the one he prefers.

The drummer initiates the playing and the rattler immediately joins in, the same rhythm being followed simultaneously by both. Many dances have a short instrumental and singing introduction, before the dancers begin. In the Corn Dance the two leading men in the line of dancers carry horn rattles, without accompaniment by a drummer or rattler on the bench.

The most frequent manner of playing the horn rattle while seated consists of contact-snapping produced by knocking the convex side of the receptacle against the left palm. The left hand usually rests on the left thigh, but may be raised up to almost a foot away from the leg. Often the rattle is snapped against the left thigh instead of against the hand, and occasionally against the right thigh or the palm of the left hand resting on the right thigh. The distal end of the rattle moves through a vertical arc of from about 3″ to almost a foot. Occasionally a roll is produced by moving the rattle horizontally back and forth through arcs about 6″

[28] Does this inscription of dates on objects exemplify the Iroquois sense of historicity? Other dated objects seen at Allegany include the longhouse cookhouse, ceremonial ashes-stirring paddles, bread paddles, and snow snakes.

[29] The position and the bench are the same as are used by the musicians for the Great Feather Dance. These are the two dances of the "Four Sacred Ceremonies" (Fenton, 1936: 13). Other similarities between the two include: similar names in reservation English ("Feather Dance," and "Second Feather Dance" or "Little Feather Dance"); both are danced in thanksgiving; both are danced on two separate days (Great Feather Dance: third and sixth days; Thanksgiving Dance: fourth and seventh days), costumed only on the second day; both are accompanied by two musicians, using primary instruments.

in length, with a snap at each end produced by abruptly reversing the direction of the swing. More rarely, the motion is in a circle of about 6″ diameter. The last two methods are almost entirely restricted to short non-dancing stretches at the beginnings and ends of song sections; the rattling and drumming speed up and become louder as the dancing gets under way. In the frequent trochaic rhythm, the softer beats may be snaps produced by swings terminating without contact from 1″ to about 8″ above the palm or leg and the louder beats contact-snaps; or else both softer and louder beats may result from contact-snaps against the palm or leg with the softer beat being merely a less vigorous stroke. Rattling always stops with the rattle at the end of an up-stroke, rather than in the left palm. The musician usually keeps time with his playing by tapping one or both heels, or sometimes in foot-heel-foot-heel fashion with the foot beat heavier than the heel one.

When horn rattles are used by leaders of a line of dancers, the usual method again consists of contact-snaps against the left palm, with the left fore-arm extended and the left elbow near the waist. More frequently than when seated, non-contact-snaps are produced. Here the beats may be at the bottom of a swing on one diagonal, with recovery, or they may be on two diagonals, V-shaped, leading to a figure-eight motion when combined with recovery. Especially at the beginning and end of song sections a steady roll may be produced by moving the rattle in a circle or rapidly back and forth vertically or horizontally. Men using a rattle while they dance seem to choose slightly heavier instruments than they do when playing seated. With these heavier ones, the hand often slides up on the handle until it nearly touches the bottom plug.

In all these methods of playing, the positions of the rattle are limited by the fact that the right elbow is always bent at an angle of 90° or less and is always kept within 3″ or 4″ of the body.

If there are no horn rattles available a tempo beater may be used as a substitute (see p. 274).

According to Fenton,[30] "references to the horn rattle appear only in the recent source material; and . . . [Lindsey Dowdy] has heard that a cylindrical bark rattle preceded the horn rattle, which seems to be of western provenience." Speck[31] obtained similar data from the Cayuga. Albert and Geneva Jones, however, had never heard of such a bark rattle; they suggest bison horn as the predecessor of the present cow horn, and do not know how long the Seneca have had this instrument.

### BOX TURTLE RATTLE

This instrument is normally referred to as *kastáwē²shæ²*, 'rattle,' or as *ká²tya·skwa² kastáwē²shæ²*, 'box-turtle rattle.' Occasionally the instrument goes by the name of the animal which provides its receptacle: *ká²tya·skwa²*, 'box-turtle,' or *ká²tya·skwa² ká²no·wa²*, 'box-turtle turtle.' It has no standard English name in use on the reservation. This is a minor instrument, used during only one ceremony, the Women's Rite, *thõwí·sas* or *wená²thõwi·sas*. However, the box turtle and the stamping sticks are the only instruments played by women in the longhouse (except for the great turtle rattle used by girls in men's clothes appearing as False Face Beggars, and the cane sticks used by women, again disguised as *men*, in Husk Faces).

The instrument (fig. 3, C) is extremely simple, consisting merely of a pellet-filled shell of a box turtle, *Terrapene carolina*, Linn. This genus of turtles has a plastron divided into anterior and posterior lobes, movable and hinged approximately at the midpoint, so that all that is necessary is to shape these lobes and fasten them to the carapace so that the pellets do not escape. The chief difficulty in the construction of the rattle is obtaining the turtle shell. All informants agree that the necessary species of turtle does not occur in this part of the country. Hence the instruments are rare. At Allegany today there are perhaps half a dozen box turtle rattles. This is more than at most times in the past and results from two recent importations of turtles, which come from "down West," i.e., areas to the southwest or south of Allegany. One recent supply of live box turtles was sent home by a young Seneca from an army camp, while another batch came via Frank G. Speck from the Philadelphia zoo. Some of Speck's shells had two holes punctured in each end of the carapace, as has an old Cayuga specimen figured by him,[32] but these were not used because "that's not our way here."

Although this instrument is owned only by women, or by the longhouse as a group, only men make them, and only three or four men now at

[30] Fenton, 1937: 127.

[31] Speck, 1949*b*: 43 and pl. XV.

[32] Speck, 1949*b*: pl. XIV.

Allegany have ever made one.[33] A woman who succeeds in getting a shell gives it to one of these men to have it made into a rattle.

The shell is soaked over night in warm water, to soften the hinge so that the plastron lobes will bend shut without cracking. It may be necessary to file the edges of one or both lobes a bit so that they will fit snugly against the lower edge of the carapace and slightly inside of it. The maker then inserts the pellets, which are usually small pebbles. Shot will do, and one maker sometimes uses chokecherry pits, although another denied that they could be used. The plastron is now bound shut with string wrapped around the carapace and around a small wooden block placed on each lobe to wedge them shut. After about two days of drying, the hinge is no longer flexible and the binding string and blocks are removed. If it is ever necessary to change the number of pellets, soaking in water will soften the hinge again. The finished instrument may be varnished or shellacked. Among the Seneca the carapace is never punctured with lines of holes, such as are seen on box turtles used on women's leg rattles by southeastern tribes, nor is a wooden handle ever inserted in such a rattle, as is done by the Cherokee, for example.

If a completed rattle is sold, it may bring as much as five dollars, owing to the difficulty in obtaining box turtles. However, if a shell is available a woman may purchase it for as little as fifty cents, then have one of the makers turn it into a rattle for twenty-five cents.

All specimens seen were 4½" to 5" long, 3¾" to 4" wide, and 2¼" to 2½" deep—larger ones are said to be too heavy and smaller ones are hard to hold.

Storage is no problem. A woman may keep her rattle in a paper bag in a drawer, in a basket on a shelf, or in any similar convenient place. It is obvious that no special care is needed to preserve the instrument for many years, and a specimen lasts for several generations if it is not lost or sold to an ethnographer.

The Women's Rite during which the box turtle rattle is used occurs on the afternoon of the eighth day of the Midwinter Festival. Each of the two appointed "head ladies" of the rite is supposed to have one of these rattles, but until recently there was only one which alternated between the two. During the first part of the rite the participating women stand in two facing parallel lines in the southwest corner of the longhouse. The two head ladies pass the rattles to each of the women in turn, for each to sing accompanying herself with the rattle, while the rest of the women sing the responses and two keep time with stamping sticks. Twice during this part of the rite a man was pulled into the line (with mock resistance from him), given a box turtle rattle, and persuaded to sing with the women. The rite ends with the women walking slowly twice around the longhouse, in single file behind one of the head ladies. The first woman in line leads with her rattle the singing which accompanies the walking, while the rest of the women sing the antiphonal responses. Few of the women are confident, strong singers, in marked contrast to the men.

The method of playing the box turtle rattle shows much more variation than with any other instrument. The songs are accompanied usually by means of slow, weak snaps, and ended with a roll produced by shaking the rattle back and forth horizontally two or three times. The snaps may be either non-contact or with contact against some part of the left hand. A duple rhythm, so common with the horn rattle, never was produced with this instrument. Beyond this there is no uniformity in the method of playing the rattle: the carapace may face in any direction; the rattle may be held rather tightly in the palm, or with the finger tips alone; the left fingers may be rather stiffly extended or loosely flexed; the right wrist may move a good deal or be almost fixed; a change from non-contact to contact snaps or vice versa midway in the song is frequent; the vertical distance moved by the right hand holding the rattle varies from about 3" to more than a foot.

Even though no local turtle has a shell which can be used to make a rattle for the Women's Rite, there has always been at least one box turtle rattle available at Allegany for as long as our informants can remember. No substitute instruments are known, and there is apparently no tradition of a previous type, although one young woman guessed that the Seneca may have obtained the rattle originally from Indians to the south, since the turtles come from that region.[34]

[33] Most of our data on construction are from Walter Jimerson.

[34] According to a myth obtained by Jeremiah Curtin from the Seneca, the *thõwi'sas* ceremony was introduced by two Seneca women captured by the Cherokee. They were instructed as to its performance by the Sky People who aided their escape and return to their own people (Mooney, 1900: 365–367). We are indebted to W. N. Fenton for this reference.

### STAMPING STICK

The stamping stick, known simply as *ka²nhyá²* or *ka²wásta²*, is among the simplest of Seneca singing tools. The only ceremony during which stamping sticks are utilized is the Women's Rite. The head ladies provide two rough poles five or six feet long, some 2" in diameter, sometimes with part of the bark removed. No great care is taken in the preparation of the sticks; they are "just picked up," and are not kept for the next performance of the ceremony.

Two of the women participating in the *thõwí·sas* use stamping sticks to accompany the singing while the box turtle rattle is passed around the two lines of women singers. The noise of the sticks is said to represent thunder, wind, and rain. The player holds the stick with both hands at about shoulder height, raises it a few inches from the floor, and thumps the butt against the floor with a slow, steady, light beat. The rhythm follows that of the box turtle rattle, but no particular attention is paid to keeping in time with either the rattle or the other stamping stick. The sticks are used not only to accompany the antiphonal singing of the women, but also as accompaniment for the Personal Chants of the individual men as they approach the women to be persuaded to sing in the Women's Rite; the women clap their hands to accompany the Personal Chants on other occasions.

During the 1952 New Year's performance of the Women's Rite, the sticks were discarded soon after the start of the ceremony and the two brooms which hang beside the longhouse doors were substituted for them. Holding the brooms upside down, the women thumped the ends of the handles on the floor.

### NON-SINGING INSTRUMENTS

Two sound-producing instruments which are not singing tools but which are used in the longhouse and were observed during the 1952 Midwinter Festival are included in this category. The large pellet bells worn by costumed dancers are a passive type of dangling, jingling, idiophones. The other type is the percussion staff or cane stick used by the Husk Faces. These instruments are simple noise-makers; they are not used to accompany singing directly. Strictly speaking, the great turtle rattle and its substitutes the bark rattle, tin rattle, and tempo beater—when knocked about, and grated, scraped or scrape-rolled by the ritual performing False Face—are not singing tools any more than the cane stick. They have been described above, however, because of their other, primary uses as musical instruments.

### LARGE PELLET BELLS

The costumes worn by the men dancers in the Great Feather Dance the afternoon of the seventh day of the 1952 Midwinter Ceremonies were almost entirely of modified modern Plains type, including eagle and turkey feather bonnets, vests, shirts, cuffs, and leggings beaded in western style. However, one element with direct Iroquois antecedents survives. Several men wore around their legs straps to which were attached "sleigh bells," *kashé·wē²ta²*. These are recognized to be modern substitutes for the deer hoof (dew claw) rattles remembered by some of the older Coldspring people. They are not a requisite part of the costume, but merely an incidental, noise-making item in a rather large inventory of possible male costume accessories.

A heavy leather strap to which are attached three commercial metal pellet bells of the sleigh-bell type, about 1" in diameter, is worn on one or both legs, around the ankle or just below the knee, underneath the pants or leggings. The pellet bells we saw were old and rusty. Some costumed dancers wear smaller, shiny bells of the same type sewn along the seams of their western-style leggings, or on their breech-clouts.

These bells jingle as their wearers dance, but the noise is not considered as 'propping up the songs.' The bells are noise-makers, not singing tools.

### CANE STICK

Another noise-making non-musical instrument of the Coldspring people is the 'cane' *atá²tishæ²*, used by the Husk Faces (*katyíhsa²*)[35] who terminate the doings on the night of the fifth day of the New Year ceremonies.

The cane sticks are "just common sticks, like broomsticks," undecorated, some 4' long and about the diameter of a broomstick. The bark is left on, or peeled a bit at one end or in the middle. Like the stamping sticks, they are prepared for each occasion separately and are not retained.

In 1952 the ceremonies on the fifth night were interrupted by a troop of nineteen Husk Faces, all wearing braided corn husk masks, five in women's clothes and fourteen dressed as men. Of the women Husk Faces at least one was a Seneca man wearing women's clothes, while some of the

[35] See Fenton, 1936: 12 f.

women and perhaps some of the men Husk Faces were disguised Seneca women.[36] Each Husk Face man carried a cane stick in his right hand. Just before the group came in the listeners inside the longhouse heard the Husk Face men circle the outside, rubbing their cane sticks along the walls as they ran around the building. The Husk Faces entered on their knees, through the women's door (at the southern end of the longhouse). One of the Faithkeepers led them in by walking backwards in front of them while he stamped the butt end of a broom on the floor with a trochaic duple beat. The men Husk Faces used their sticks as canes as they entered, tapping them heavily against the floor. Since Husk Faces do not talk or sing, the cane sticks are not singing tools. When the Husk Faces were all inside the building, they stacked their canes against the stove in the south end of the longhouse and participated with the Seneca in the longhouse in about an hour and a half of enthusiastic dancing (Traditional Women's Dance and Fish Dance).

## OTHER INSTRUMENTS

In this section, we shall mention briefly the four types of Coldspring singing tools which are used mostly outside the longhouse in individual homes, and which were not used at all in the longhouse during the 1952 Midwinter doings: rasping sticks, big water drum, flute, and rattles of various types.

### RASPING STICKS

The rasping sticks, ***kanó²oskæ·²***, are never used in the longhouse. They are only seen at "wakes," and even for this purpose they are rare at Allegany, although known to be used more frequently among some Canadian Iroquois: "even a baby dies, they do." It is necessary to make a new pair of sticks for each wake at which the instrument is used, for the rasping sticks are buried with the body of the individual for whom the wake is held.[37]

The instrument consists of two sticks of some soft, easily carved wood such as hemlock, *Tsuga canadensis*, Carr. No specimens were examined by the authors,[38] but informants described two flat sticks measuring about 10″ × ½″ × ⅛″. One of these had notches "like a saw" cut along all but the upper one-third of one narrow edge, while the other had smoothed, slightly rounded edges.

In playing, the upper unserrated third of the notched stick is held in the left hand, with the lower end resting against the left leg near the knee. No resonator is used. The rasping stick is held in the other hand and rubbed over the notched edge only in a downward direction, the recovery to the upper position being made without rasping. The rhythm follows that of the accompanying drum. The rasping sticks are passed in turn to each of the fifteen or twenty men present as each accompanies the drummer, who leads in the singing.

According to our informants, this instrument is "one of the old-timers." Fenton[39] says that it is "said to represent human bones."

### BIG WATER DRUM

In Seneca, the Allegany people call this type of water drum ***ohkí·we ka²nõhkwa²***. In English, they refer to it as "Chanters of the Dead drum," "ladies dance drum," or just "big drum." As the names imply, it is used only on one occasion, during the all-night Feast of the Dead, ***ohkí·we***. It is the sole instrument used during this ceremony and is played by a man.[40] The ceremony, which is for "the sick and passed ones," is only rarely held in the longhouse. The night after the last day of the 1952 Midwinter Festival, a Feast of the Dead was held at Albert and Geneva Jones' house, but it was not witnessed by the writers. A description of recent ***ohkí·we*** ceremonies at Six Nations Reserve, in Canada, including an analysis of the music, has been published.[41]

A drum of this type differs from the previously described smaller water drum only in its greater size. The relatively larger dimensions are illus-

[36] Our informants agreed that a member of either sex may disguise himself or herself as a member of the other, but disagreed as to whether on this occasion there were any Seneca women dressed as Husk Face men.

[37] As Geneva Jones told us, "Sticks they made purpose for that—they throw down in casket with it—that's sad, that's the reason we don't do it but very seldom around here." Fenton writes, "I remember clearly at Tonawanda two wakes in which I participated and seeing the conductor break the rasps at dawn, and burn them together with the pointer, and drum beater. The head is taken off the drum till after the Ten Days Feast" (personal communication).

[38] See the photograph in Morris, 1914, facing p. 184, of a Seneca example differing but slightly from the type described here. Speck, 1949*b*: 44 and pl. XV, describes a Cayuga specimen of a different sort.

[39] Quoted in Roberts, 1936: 26 f.

[40] According to Morgan (1901: **1**: 275) during the ***ohkí·we*** "the music was entirely vocal." Our Allegany informants told us that a big drum must be used to accompany the singing, and Fenton writes us that Morgan never saw this ceremony.

[41] Fenton and Kurath, 1951.

trated by the measurements taken from one typical specimen: height, 4½"; diameter of drumhead (rim to rim) 7".

For the drumhead, thicker skin (frequently from a cowhide boot top) is necessary than for smaller drums. Beaters are usually plainer in design and are correspondingly longer and heavier than those used with smaller drums. Of several specimens measured, the average dimensions are: total length, 10¼"; thickness at neck of shaft, 5/16"; diameter of the head, ¾".

As might be expected the tone produced by a big water drum is deeper than that of the smaller type. This, said one informant, is "because *ohkí·we* songs are lower."

### FLUTE

The only aerophone used by the Allegany Seneca is a flute or whistle, *ká?kẽ·ta?*. It has no stops; the "white man's flute," *yé·õtawástha?*, with fingering holes, is not used by the Coldspring people. This "Indian flute" is used during the rites of the Little Water Medicine Society and during the Eagle Dance.[42] The instruments used for both purposes are not identical; although they are called by the same name and are apparently constructed in a similar manner. They are kept by different people. The Eagle Dance one may be lent out whenever requested whereas the other one may not.

An Eagle Dance specimen seen briefly from a distance was about eighteen inches long, of bamboo, and had a black stripe around the tube. A block was tied over the whistle opening—apparently an outside flue[43] of the common North American courting flute type.

In the Eagle Dance the flute is used with a drum and horn rattle. Two notes are produced, the higher one, an octave above the lower, being produced by over-blowing.

The rites of the Little Water Medicine Society are always held in private houses, and the Eagle Dance is also usually celebrated in individual homes, as it was the night of the fourth day of the 1952 Midwinter Ceremonies. Rarely the Eagle Dance is held in the longhouse, but not as a part of the New Year's doings.

[42] See Fenton, 1936: 17, and Fenton, 1953.

[43] See Sachs, 1940: 193–194 for a definition; Baker, 1882: Tafel II Fig. I for a cross-section of such a flue; and the following for illustrations of Iroquois flutes with outside flues—all, however, with stops: Boyle, 1898: figure 21; Morris, 1914: facing p. 124 (specimen number 3541); Speck, 1945: 77; Speck, 1949*b*: pl. XV, F.

### BIG GOURD RATTLE

This instrument is used only for the ceremonies of the Society of Mystic Animals, *íi?to·s*,[44] hence one name for it is *íi?tostha? kastáwẽ?shæ?*, 'Society-of-Mystic-Animals rattle.' If attention is directed to its principal component part the rattle may be termed *onyõhsa? kastáwẽ?shæ?*, 'gourd (pumpkin, squash) rattle.' Fig. 3, D shows a common form of the gourd rattle. An average size example has a gourd, "punkin," or squash receptacle 5" to 7" long with a maximum diameter of some 6" or 7". A small specimen seen was 10½" in overall length.

The receptacle is mounted on a wooden stick passing through the gourd leaving a handle 6" or 8" long. This handle has a round shoulder and a flange which fits inside the receptacle, a construction paralleling that of the horn rattle without a bottom plug. The receptacle is not nailed or pegged to this flange. The round distal end of the handle projects about ½" beyond the gourd and has a hole through which a wooden pin is forced, holding the receptacle tight against the shoulder. Every specimen seen had a hole for a hanging string in the proximal end of the handle. In cross section the handle is usually round, and may be plain or wrapped with black tape. "Shots" from a number six shell are used by one maker for pellets. It is probable that the Society of Mystic Animals at Coldspring may also use a rattle made of a whole gourd or squash with the seeds dried inside,[45] but no such rattles were seen by the authors.

One substiute for the big gourd rattle which was made by Chauncey Johnny John (a Cayuga, long resident at Allegany) and used while he was still living had a coconut receptacle. This specimen, called *onyóo?kwa? kastáwẽ?shæ?*, 'coconut rattle,' is apparently the only one of its kind known to Allegany informants.[46] It is 12½" in overall length. The construction is like that of the gourd rattle except that the hanging loop is a wire in a groove around the handle, and there is no pin in the distal tip of the handle. Instead, another piece of wire is wound around the stick after the latter passes through one of the three eyes of the coconut shell.

The Society of Mystic Animals rites are normally held in private houses (such a ceremony occurred the night of January 26, 1952), and only very rarely in the longhouse—"one in ten years,

[44] See Fenton, 1936: 17.

[45] *Cf.* Speck, 1949*b*: 43 and pl. XV, C.

[46] This rattle is now in the Yale Peabody Museum.

maybe, but we ain't had any for a long time." This is not essentially a longhouse singing tool.

### SMALL HORN RATTLE, SMALL GOURD RATTLE

Although the large horn rattle and the large gourd rattle are similarly constructed, they do not share the same ceremonial uses. However, this distinction is not maintained for small-sized rattles made in the same manner. Boys performing in the Eagle Dance shake either a small horn rattle or a small gourd rattle in their right hands while dancing, holding a feather wand in the other hand.[47] The dancers do not sing as they dance but vibrate their rattles in time with the water drum and large horn rattle of the accompanying men singers.

These small rattles are about 8″ in total length. Two small cow horn rattles examined differed from the large ones in having hanging strings on the proximal ends of the handles, and especially in lacking separate top plugs—the handle, bottom plug, and top plug were all in one piece—the part of the handle inside the receptacle having been shaved down to provide room for the pellets.

## CONCLUSIONS

All Seneca musical instruments except the flute are either idiophones or membranophones. There are no chordophones, and the only aerophone is the flute, which is not a midwinter longhouse instrument.[48] All singing tools at Coldspring longhouse are hand instruments—small in size, light in weight, without supports or fastenings, and are always held by an individual player. Despite their portability, most instruments are played by seated musicians.

Seneca musical instruments are preeminently *tools*. They are not art objects: in general, decorative elements of color, design, and shape are deemphasized. Emphasis is placed on use, which is often sacred; manufacture is entirely secular. Individual ownership is relatively unimportant: instruments are freely lent, often given, and are not important commercial items. Instruments are inherited by those who can best use them, there being no other significant criteria. Only utilitarian considerations are involved in methods of care and storage; there is no associated ritualistic behavior.

Longhouse instruments when musically played are always associated with singing. Hence they are aptly called *singing* tools. All instrumental musical accompaniment is rhythmical, never melodic. Most rhythms are basically duple. While simple duple time is normal in introductions and intervals between stanzas, trochaic duple time is most common during the main sections of songs. Singing with instrumental accompaniment is in most cases associated with dancing.[49] A man [50] is chosen to play and sing largely because of his knowledge of specific songs; quality of singing voice and skill with the instrument are secondary.

The unique position occupied by musical instruments is emphasized if we examine the material culture of the Allegany Seneca in terms of the categories recently developed by Quimby and Spoehr.[51] All acculturative changes in material objects are divided by these authors into two major groups: A. New types of artifacts introduced through contact, and B. Native types of artifacts modified by contact. If we accept the arbitrary polarity of this division of the continuum of types of change, then almost the entire material culture of the Coldspring people is a result of changes of Type A. On the other hand, where singing tools have been affected at all, the changes were entirely of Type B.[52]

[47] See Fenton, 1953, and Speck, 1949*a*: 49.

[48] Sound-instruments have been classified according to the method by which the sound is produced. Hornbostel's definitions of the primary categories are: Idiophones: "Vibrations produced in the substance of the instrument itself." Membranophones: "Sound produced by a membrane stretched over an opening." Chordophones: "A stretched string is primarily made to vibrate." Aerophones: "The air itself is primarily made to vibrate." Hornbostel, 1933: 303–311. See also Sachs, 1940: 454–467.

[49] Singing may also occur alone (e.g., Personal Chant) or with dancing unaccompanied by instruments (e.g., Stomp Dance).

[50] The Women's Rite is the only Midwinter longhouse ceremony which involves female musicians.

[51] Quimby and Spoehr, 1951.

[52] Aside from musical instruments the only survivals of native types of artifacts observed by the authors were: (household objects) two or three wooden mortars and pestles, plain mush and bread paddles, two carved wooden spoons, two or three elm bark trays, half a dozen corn preparation baskets and some other baskets in use in homes; (games) some 75 snow snakes, a few locally-made lacrosse sticks; (ceremonial costume) six pairs of women's leggings, four or five women's skirts, eight or nine women's overdresses, two sets of husk rope costume accessories, no mocassins and no items of Iroquois men's costume; (other ceremonial artifacts) some 25 husk face masks, some 15 wooden masks, about a dozen ashes-stirring paddles, one peach stone game (wooden bowl, peach stone dice, and bean counters), one bow and arrow (used during the Personal Chants), two rough wooden pestles.

Aboriginal forms and functions of singing tools have persisted almost without change. The only apparent changes—both of Type B—are in the materials used and in the techniques of manufacture. For instance, commercial leather may be used for drum heads or shot for rattle pellets. The area in which change with regard to singing tools is most noticeable is in the implements used to construct them, where there has been an almost complete substitution of European tools, though it should be noted that Iroquois tool-using motor habits may have persisted—the jackknife is drawn towards the worker's body in smoothing the handle of a horn rattle.

Historic change of Type A has gone so far in all the rest of material culture that today the Seneca inventory of possessions is hardly distinguishable from that of their white neighbors. Musical instruments alone have persisted as a well-integrated complex of largely aboriginal material traits.

## OUTLINE GUIDE FOR GATHERING DATA ON INDIVIDUAL MUSICAL INSTRUMENTS

I. Names.
   A. Seneca.
   B. English.

II. Form.
   A. Component parts.
      1. Materials: variation and range; dimensions.
      2. Size and shape: variation and range; dimensions.
   B. Overall form; variation and range; drawings, photographs, dimensions.
   C. Individual stylistic variations.

III. Manufacture: variation and range.
   A. Makers: sex, specialization.
   B. Source and preparation of materials and component parts: where; when; how, tools used; why.
   C. Techniques of assembly.

IV. Use: variation and range.
   A. Ownership and ownership marks by sex, specialization, group; negotiability and prices.
   B. Care: where and how kept; methods of preservation and repair.
   C. Durability.
   D. When used (on what occasions); for each occasion used:
      1. Where used.
      2. How many instruments of the same type.
      3. By whom; sex, specialization.
      4. Manner of use.
         a. Manner of holding and moving instrument.
         b. Other postures, positions, movements of player(s).
         c. Quality, loudness, pitch, rhythm of sounds produced.
         d. Length of time played, and of pauses.
         e. Associated behavior: singing, dancing, other instruments, rhythm keeping, etc.
      5. Obligatory or optional.
      6. Possible substitutes.

V. Occurrence.
   A. Number of specimens in community.
   B. Number of specimens per owner.

VI. Traditional history.
   A. Origin: when, how, where.
   B. Age of present usages.
   C. Former usages now lost.
   D. Modifications and substitutions in form, materials, etc.

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# BASIC DATA ON THE EMERGENCE OF DECIDUOUS TEETH IN THE MONKEY (MACACA MULATTA) [1]

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No truly complete and biometrically satisfactory chronology of dental development in any species of mammals has been published up to the present time. This is due, primarily, to the extreme difficulty of securing a sufficient quantity of reliable raw data, without which no meaningful mathematical analysis can be attempted. The purpose of this study is to supply several of the missing biometric essentials which are needed for describing the development of the deciduous dentition of one species of primates.

Among the best studies on the emergence of deciduous teeth in man are those by Robinow, Richards, and Anderson (17),[2] Doering and Allen (4), and Sandler (18). These investigators have not attempted to summarize previously published statistical reports which deal with the subject. A most useful bibliographic review, however, has been prepared by Meredith (12).

The most complete report to date on an infrahuman primate is that by Nissen and Riesen (14) on the deciduous dentition of the chimpanzee. Although hampered by the limited amount of raw data at their disposal, these authors have considered such important details as the character of frequency distributions, correlations with length of gestation, sex differences and individual consistency in rate of dental development.

As regards the chronology of dental development in other primates, the data are very scanty. The outstanding reports published so far are those by Schultz (21, 22) on the eruption of both deciduous and permanent teeth in the "rhesus" monkey (*Macaca mulatta*) and that by Spiegel (26) on the two dentitions of *Macaca irus mordax*. These papers deal with observations on rather small numbers of animals of known age and their authors do not attempt any extensive statistical description of the material. Only approximate arithmetical averages, the general sequence of eruption and the limits of the ranges of variation for the groups studied are presented.

The paucity of accurate recorded observations on the deciduous teeth of living apes and monkeys is illustrated further by the limited number of reports which contain detailed data on single specimens reared in captivity. The authors have seen only four such publications (3, 10, 20, 28).

The remarks made in the preceding paragraphs do not apply with equal force to the studies on the order, or sequence, of eruption of different classes of teeth in various species of primates, a subject which has been reviewed most fully by Krogman (9) and by Schultz (23, 24, 25). The work by Zuckerman (31) on the development of the dentition in the chimpanzee and by Baume and Becks (1) on that of *Macaca mulatta* can be cited as good examples of this type of study. It can be said, nevertheless, that even this last-mentioned subject is due for some revision in the future as more precise data are accumulated.

The establishment of good statistical norms for various stages of dental development in man and other primates is of greatest theoretical value for a number of reasons. It is hardly necessary to stress the value of such data to the experimental biologist and to the student of evolution. Of less obvious significance is the value of such information to the cultural anthropologist, paleontologist, nutritionist, pathologist, and medicolegal expert. Estimates of the chronological age of captured young wild animals would also be facilitated were some established biometric standards available.

The present report is based on observations recorded in the monkey colony of Doctor G. van Wagenen, at the Medical School of Yale University, New Haven, Connecticut. The monkey colony there was established in 1931. The records on tooth eruption discussed in this paper comprise 99 individual series of observations accumulated between the early part of 1935 and the end of 1950,

[1] This investigation was supported in part by a research grant from the National Institutes of Health, Public Health Service, to Yale University School of Medicine. The Nutrition Foundation, Inc., gave generous aid during the time the data were gathered.

[2] Numbers in parentheses indicate references at end of article.

and cover the infancy periods of some five generations of *Macaca mulatta* reared in captivity. These animals are not the product of intensive inbreeding, since they are the offspring of over 80 different parents. It may be said that the group as a whole is definitely heterozygous.

The actual examination of the animals and the recording of observations during these fifteen years were carried out by one and the same person.[a] The criterion for tooth emergence during this period remained the same, namely, the first appearance of a tooth crown, or any part thereof, above the oral mucosa. Thus the criterion employed is the same as that of Spiegel, and Nissen and Riesen, but different from that of Schultz.

On the basis of a review of many other research reports on erupting teeth the authors are very definitely of the opinion that, for the purposes of most clinical and laboratory studies, the criterion employed in the present investigation is the least ambiguous of all criteria devised so far. Schultz (22) recorded a tooth "as erupting not when merely the first, small, white tip of a cusp appears through the gum, but rather when the entire top of the crown has just pierced the gum, though the tooth is still far from functioning by meeting its antagonist in the other jaw." Dissatisfaction with this definition of eruption arises from the fact that "the entire top of the crown" is too vague a concept to be interpreted in a like manner by everyone. This is particularly true of the incisors and canines, which have no occlusal surface. The criterion used by Schultz also has the disadvantage of not being one that is generally accepted. In comparing his figures with those reported by others it is necessary to assume that the former are somewhat too high. Unfortunately the exact intervals of time between the initial piercing of the gum and the stage when "the entire top of the crown" is visible are not known for the different teeth, nor are they likely to be the same for all animals even within one species. This makes it difficult to compare the eruption data of Schultz with the data given by others.

This study is confined to data on monkeys believed to be normal and healthy. A few cases of definite or questionable rickets, which occurred early in the history of the colony, were excluded from this investigation, as it is known, from clinical observations on children, that this disease is frequently accompanied by appreciable retardation of dental development. One case of fatal infantile diarrhea was left out. Excluded also were the dental records of several castrated males, as well as of numerous males and females that had received testosterone propionate either directly, by injection, after birth, before the deciduous dentition was completed, or indirectly, by injection of the mother during the prenatal period. There is rather clear evidence, as shown in a paper by van Wagenen and Hurme (30), that this hormone preparation can modify the schedule of dental development to a considerable degree in the monkey. Corroborative evidence is given in a report by Palmer, Katonah, and Angrist (16), who studied the effects of various biologicals, including cortisone, on the growth of rats and the eruption of their incisor teeth.

A few cases of transient cage paralysis were not held to be of sufficient significance to justify classifying the animals among the abnormal or unhealthy. One case of minimal skin tuberculosis and two of gastrointestinal disturbances in infancy were also included in the "normal" series.

The statistical handling of the recorded data on tooth emergence imposed a number of problems of a very practical nature, the first of which was the selection of an appropriate unit of time for expressing the postnatal age of an animal on the date when some part of a given tooth crown was designated as having appeared above the gum line. Expressing this age in terms of years, months, and days, as is ordinarily done, would have required a moderately time-consuming calculation for each tooth. The length of a "month" would have had to be arbitrarily decided in many specific instances. Even if the employment of a "month" had been eliminated, calculation of age in terms of years and days (or years, weeks, and days) would have been cumbersome, in addition to being subject to occasional small errors. Since the number of separate computations required for each animal was determined by the total number of individual teeth—both right and left—it was obvious that some simplification of the practical procedure to be followed was highly desirable.

The problem of simplification was of importance also for a second reason, namely, the desirability of having the numerical data in a form that was convenient for statistical manipulation. Calculations that involve several nondecimally related time units require considerable work and constant

[a] The authors wish to express their appreciation for the invaluable services rendered by Mr. Joseph Negri, technical assistant, whose faithful attention to detail has insured the high quality of the raw data at their disposal.

checking and rechecking for the avoidance of error. This becomes a major consideration when the number of calculations is even moderately large.

With the above-mentioned points in mind, the basic time unit chosen for all statistical operations was the year. However, inasmuch as a year is much too large a unit for dealing with the details of as rapid a physiologic process as tooth eruption, it was necessary to supplement it with some considerably smaller time unit. A hundredth of a year was found to meet all practical requirements. It is not too large a unit (1 day = 0.00274 yr.) to introduce any significant distortions of time values in a study where the basic data, with very few exceptions, involve time periods clearly in excess of one hundredth of a year, or 3.65 days. In fact, it can be emphasized that the expression of age spans which are never accurate to 0.365th of a day, or a thousandth of a year, in terms of years and hundredths of a year causes procedural errors that are negligible.

The decision to designate age in the manner just described necessitated finding a speedy and accurate technic for determining the decimal fraction of a year between any two dates, one of which is the birthday of an animal and the other the month and day on which an observation was made. This practical problem was solved by constructing a special "slide rule," in which the edge of the centrally pivoted, rotating inner circle was graduated into 730 equal divisions representing the number of days in a two-year period, while precisely one half the edge of the fixed outer circle was divided into 100 equal parts, representing hundredths of a year (see fig. 1). With this device the decimal equivalents of fractions of a year could be ascertained with very little effort and with virtually no chances of error.

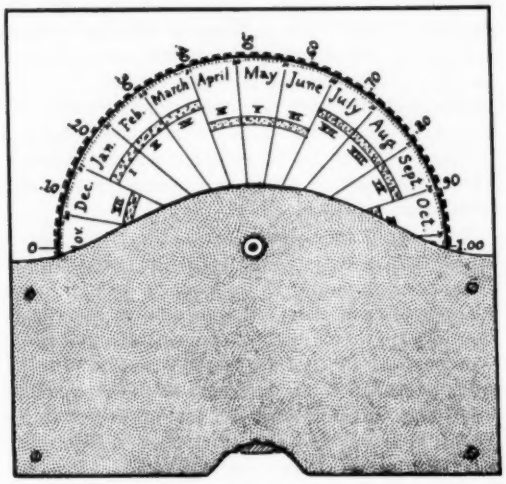


FIG. 1. A sketch of the device used for determining the decimal portion of a year between any two calendar days. The circular inner plane, with months and days, can be rotated by pushing with thumb or finger against the transversely grooved edge of the plane, part of which is visible in the shallow notch cut in the center of the lower border of the instrument.

Occasionally it was found convenient to employ another technic for finding the decimal equivalent for a period of less than 365 days. If the number of days (plus one day) between two dates was known, or readily computed, referral to a precalculated conversion table was all that was needed to determine the nearest hundredth of a year corresponding to the period in question. Since almost all spans of time calculated from the data discussed in this paper are expressed in terms of decimals of a year, the reader may find table XIV (p. 313) a useful adjunct in interpreting some of the material given in tables I to XIII and in figures 1 to 10.

After determining, for each tooth, the postnatal age of the animal at the time of emergence of the tooth and after making these determinations for all 97 animals in the "normal" series, the data pertaining to a given morphologic class of teeth were pooled. The number of tooth pairs studied is shown in the third column of tables VI and VII. The emergence values in a pooled series were then arranged in an orderly sequence on the basis of increasing age. Table I illustrates the material available for calculating the various biometric values that describe the emergence of the deciduous maxillary first molar in a series of 50 normal female monkeys.

It will be noted that in preparing the listing shown in table I the emergence ages for a given pair of teeth, that is, a tooth and its antimere, have been averaged. This technic was followed in all cases where there was very little (less than 0.02 or 0.03 yr.) or no asymmetry in the process of emergence of a tooth pair. As a general rule, good bilateral symmetry prevails in the eruption of the deciduous teeth; at any rate existing asymmetry is too small to be detected when the interval between examinations is not less than one day. By comparing cumulative frequency curves based on data in the form of averages with similar graphs plotted by using unaveraged values, it was found

that the differences in the shape of such curves were minimal and did not warrant the use of unaveraged figures when the instances of asymmetry in a series were either very few, or the degrees of asymmetry very small.[4]

TABLE I

EMERGENCE OF DECIDUOUS MAXILLARY FIRST MOLARS IN 50 NORMAL FEMALE MONKEYS

(Age of emergence refers to the average for a tooth pair)

| Animal no. | Age at emergence (yrs.) | Cumulative percentage | Identification number of plotted point |
|---|---|---|---|
| 37 | .120* | 2 | 1 |
| 44 | .130 | | |
| 60 | .130 | 6 | 2 |
| 9 | .140 | | |
| 20 | .140 | | |
| 36 | .140* | 12 | 3 |
| 61 | .145 | 14 | 4 |
| 8 | .150 | | |
| 26 | .150 | | |
| 35 | .150 | | |
| 39 | .150 | | |
| 52 | .150 | | |
| 53 | .150 | 26 | 5 |
| 10 | .160 | | |
| 29 | .160 | | |
| 45 | .160 | | |
| 50 | .160 | | |
| 51 | .160 | 36 | 6 |
| 19 | .170 | | |
| 31 | .170 | | |
| 38 | .170 | 42 | 7 |
| 49 | .175 | 44 | 8 |
| 2 | .180 | | |
| 5 | .180 | | |
| 7 | .180 | | |
| 48 | .180 | | |
| 62 | .180 | 54 | 9 |
| 3 | .185 | 56 | 10 |
| 4 | .190 | | |
| 16 | .190 | | |
| 22 | .190 | | |
| 58 | .190 | 64 | 11 |
| 6 | .200 | | |
| 17 | .200 | | |
| 56 | .200 | | |
| 57 | .200 | 72 | 12 |
| 14 | .210 | | |
| 23 | .210 | | |
| 59 | .210 | 78 | 13 |
| 28 | .215* | 80 | 14 |
| 34 | .220 | | |
| 67 | .220 | 84 | 15 |
| 11 | .250* | | |
| 12 | .250 | | |
| 13 | .250 | | |
| 15 | .250 | 92 | 16 |
| 18 | .260 | 94 | 17 |
| 30 | .270 | | |
| 55 | .270 | 98 | 18 |
| 25 | .290 | 100 | 19 |

* Slightly asymmetrical emergence.

The experience gained in analyzing numerous reports dealing with tooth eruption in man and other mammals has made it quite clear that the bulk of the literature on this subject is highly unsatisfactory from the point of view of a biometrician. None of the published accounts seen by the authors furnish a fully acceptable prototype for the statistical handling of any new data on the phenomenon of tooth eruption. Therefore, since it is impossible to refer the reader to some publication which would give the reasons for the critical remarks just made, it is necessary, at this point, to touch upon some of the most serious shortcomings evident in many of the earlier studies. It is hoped that by so doing the reader will get a better understanding of the reasons which underlie the selection of the procedures followed in analyzing the material upon which this report is based.

The one outstanding deficiency which characterizes a surprisingly large proportion of biometric studies on tooth emergence stems from the failure of many workers in the past to realize that some of their original data did not represent random samplings from the "universe" of erupting teeth. Only because of a fortuitous combination of circumstances in certain specific instances are some of the earlier statistics on tooth eruption still acceptable. Since no sufficiently detailed critical analysis of the world literature on tooth eruption has been published, the biologist who is interested in the problem today must scan each separate report with great care before he can know what statistical measures can be accepted without reservation, what must be subjected to recalculation and what must be rejected.

Statistical expressions such as the mean, standard deviation and standard error of the mean are helpful only in so far as they are based upon data which represent more or less random samplings from an aggregate with a common characteristic. Data on erupting teeth do not meet the criterion of randomness unless the age range of the group from which the sample is drawn is sufficiently wide to include both ends of a given frequency distribution, if not fully, then at least approximately. It is unfortunate that, in acquainting anthropologists and dentists with the use of statistical measures such

[4] In dealing with the emergence of most permanent teeth the bilaterality of the timing of development processes is frequently too poor to permit the employment of averages. The degrees of chronologic asymmetry increase with age.

as the mean and the standard deviation for describing the eruption of teeth, Boas and Wissler (*2*), Spier (*27*), and Hellman (*6, 7*) did not stress the necessity of securing adequate data before making the computations, but assumed this point to be self-evident to all students. The ranges of variability are so great for many classes of teeth that it is frequently very difficult, or even impossible, to obtain data on a sufficiently large number of individuals in each age group to provide all the raw material necessary for a truly authoritative statistical description of the phenomenon under study. The age limits of a given group of children (or of the young of any species of mammals) may be such as not to permit the making of observations which cover the full range of variability of each and every morphologic class of dental organs. Likewise, for purely practical reasons, the groups available for study may be too few in numbers to provide accurate data on the extremes of a given frequency distribution. In either case, the biometrician does not obtain a truly random sampling for computing the statistics desired.

Fortunately, the raw data on the emergence of deciduous teeth in the monkey colony at Yale University are not weakened by any restrictions imposed by artificial age limits, which would cut off material from one or both ends of the age range of deciduous tooth emergence. Since the material utilized consists of serial (or "longitudinal") observations on a single sizeable colony of primates, rather than of a compilation of "cross-sectional" material on several different, more or less unrelated, colonies of animals, one may say that every age period of one or more days is represented by the same number of individuals for each class of teeth. This statement acquires considerable significance if it is recalled that the basic data consist of daily observations for all teeth except the second molars.

Previous experience had demonstrated to one of the authors (V. O. H.) the extreme usefulness of the cumulative percentage curve in preparing raw material on tooth eruption for further statistical treatment. Hundreds of individual graphs depicting the eruption of teeth in man, and all of the graphs made in the course of this study, reveal the striking uniformity of the group pattern that characterizes this phenomenon in both man and monkey. The cumulative frequency graphs based on sufficiently large numbers of observations are, without exception, so called ogives, or reflex curves, which are remarkably smooth and regular, and of the same general shape for all classes of teeth (see fig. *2*). They vary most in the steepness of the slope in the midrange.

Because of the uniformity just mentioned it is a relatively simple matter to fit a smooth frequency curve to a series of points which can be plotted from a tabulation such as the one shown in table I. The nineteen cumulative percentage levels obtained from the raw data on the maxillary first molars of

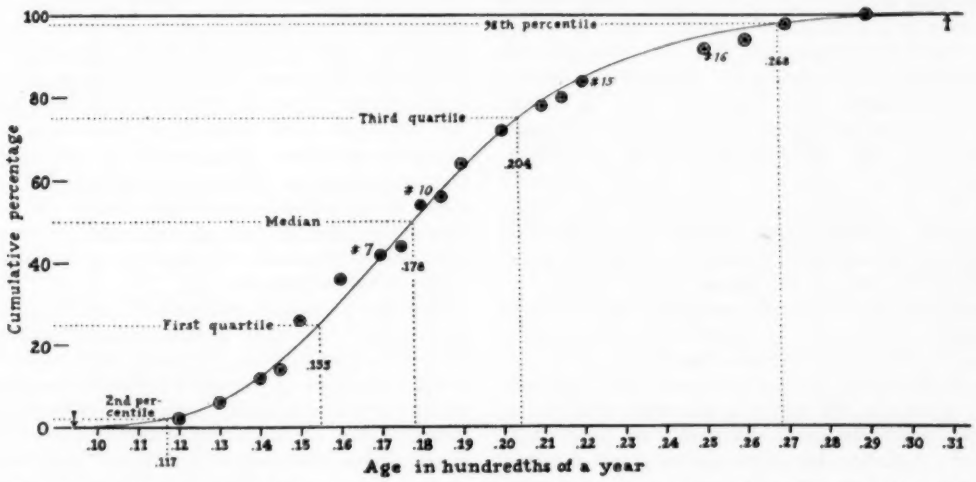


FIG. 2. A cumulative percentage ogive drawn free-hand to give the "line of best fit" to the 19 points furnished by the data in table I. The ends of the curve are indicated by small arrows. The method of determining various percentiles is shown also.

females, and the ages at which these levels were reached, are shown in the graph reproduced in figure 2.

Inspection of the plotted points reveals clearly that their position on graph paper is so systematic as to make it quite easy to draw, free-hand, a continuous smooth line which describes the general relationship between age and the probability of the tooth being present in the oral cavity at any given age. Such a line is, of course, a special type of a curvilinear regression curve which, undoubtedly, can be accurately located by an expert in advanced statistical methods. Locating the line by the simple technic of trial and error appeared sufficient for the purposes of this study. Care was taken always to so draw the ogive that the individual points would exhibit a minimum of deviation from it; in other words, an effort was made to establish a "line of best fit" without recourse to complex mathematical procedures.

Since the main objective was to obtain an idea of the statistical character of tooth emergence in an infinitely large population of macaques, it appeared logical to base all subsequent computations for a tooth upon what might be called a "realistically idealized" cumulative frequency curve describing the findings recorded for that tooth. The method of drawing this curve was partially described in the preceding paragraph.

Two supplementary remarks must be added to this description. First, whenever there was any difficulty in deciding, on the basis of the plotted points, just what shape to give to the curvatures of the ogive "regression" line, the final decision was made by visualizing the repeatedly appearing general pattern which had been found to characterize all graphic representations of more adequate statistical data. Second, since it was most desirable that the frequency curve should depict, as closely as possible, the state of affairs in a truly random, infinitely large population of emerging teeth, it was deemed advisable to draw the lower and upper ends of the curve in the manner suggested by the universally occurring curve pattern already mentioned. This meant, in practice, starting the curve from the zero line from a point more or less to the left of the first plotted point, and ending it on the 100 per cent line somewhat to the right of the last point obtained from the data at hand. Locating the approximate point of origin on the zero line generally presented no difficulty, but deciding where to place the upper end of the curve was frequently more troublesome, because of some positive skewing of most frequency distributions.

It could be argued that starting with a smoothed frequency polygon would be a better method of procedure. It is to be noted, however, that the shape of even a perfect Gaussian or "normal" curve of distribution is more complex than that of a cumulative curve and therefore more difficult to sketch free-hand, especially if the number of plotted points is small, or the intervals between them unequal. (Note, as an example, in figure 2, the long "empty" interval between the points numbered 15 and 16, and the relative closeness of points 7, 8, 9, and 10.) The employment of a mathematical procedure would not wholly eliminate this difficulty. In actual practice it is easier to derive a smooth, or idealized, frequency distribution curve indirectly from a cumulative curve than directly from the unprocessed data that are being studied. This is especially true when the distributions are not quite symmetrical.

Starting the biometric analysis by drawing a cumulative frequency curve also has the added advantage of making it easy to compare the general character of a distribution pattern suggested by limited data with the pattern suggested by more ample material. In this particular study there were several opportunities for such comparisons, as more observations became available for male monkeys after the statistical analyses had been started. In each specific instance it was found that the addition of even as many as 8 cases to a previous series of 30 or more observations did not materially alter the general *shape* of the cumulative frequency curve, and in no instance was the value of the standard deviation computed from the smoothed curve altered by more than one-hundredth of a year. The number of observations had a much greater influence on values such as the mean, median, and mode, which describe the *location* of the curve on the time axis, than on the figures which expressed the degrees of variability revealed by the samples.

The unequal class intervals of the frequency distributions furnished by the material analyzed (see table I and figure 2) would have made the direct calculation of standard deviations unnecessarily cumbersome, as it would have been impossible to follow the statistical procedures ordinarily employed for analyzing data that can be grouped in sufficiently small, but equal class intervals. Since the cumulative frequency curve provides one with a free choice of convenient class intervals,

difficulties due to this technical detail are eliminated.

Following the technic just described, cumulative percentage curves were constructed on the basis of the data available for each morphologic class of deciduous teeth. Tables II and III summarize the numerical values obtained for selected percentile points on the smoothed curve. These data are presented in full, since many investigators prefer the use of percentiles for the statistical description of frequency distributions which may be skewed.

All data pertaining to deciduous second molars, both maxillary and mandibular, have been corrected for the probable error which is the result of changing from daily to weekly inspection of teeth after three months of age. Weekly examinations do not enable one to say whether a tooth recorded as present for the first time actually pierced the mucoperiosteum *almost* seven days prior to the moment of examination, only a few hours earlier, or at some other time between these limits. Therefore, it is necessary to treat the recorded data by assuming that in the majority of instances the emergence of a tooth occurred half a week prior to the date of examination. Since 7 days is approximately 0.02 of a year, a half week correction necessitates subtracting 0.01 of a year from all age figures obtained for the second molars. The curves for these teeth, in figures 3 and 4, are in the "corrected" position in relation to the horizontal ordinate, or time axis.

An inspection of tables II and III reveals at a glance the general similarity of all values for males

TABLE II

PERCENTILES OF AGE DISTRIBUTION OF EMERGENCE OF DECIDUOUS TEETH OF MALES

Data expressed to the nearest hundredth of a year.

| Teeth | | 2nd Percentile | First Quartile ($Q_1$) | Median ($Q_2$) | Third Quartile ($Q_3$) | 98th Percentile |
|---|---|---|---|---|---|---|
| Max. | Mand. | | | | | |
| - | $di_1$ | 0.00 | 0.02 | 0.04 | 0.06 | 0.10 |
| $di_1$ | - | 0.00 | 0.03 | 0.05 | 0.07 | 0.11 |
| - | $di_2$ | 0.00 | 0.04 | 0.06 | 0.08 | 0.13 |
| $di_2$ | - | 0.04 | 0.08 | 0.10 | 0.13 | 0.18 |
| dc | - | 0.10 | 0.16 | 0.18 | 0.21 | 0.26 |
| - | dc | 0.11 | 0.16 | 0.19 | 0.22 | 0.27 |
| $dm_1$ | - | 0.13 | 0.17 | 0.20 | 0.22 | 0.27 |
| - | $dm_1$ | 0.14 | 0.19 | 0.21 | 0.23 | 0.28 |
| - | $dm_2$ | 0.31 | 0.37 | 0.41 | 0.45 | 0.52 |
| $dm_2$ | - | 0.33 | 0.40 | 0.44 | 0.49 | 0.58 |

TABLE III

PERCENTILES OF AGE DISTRIBUTION OF EMERGENCE OF DECIDUOUS TEETH OF FEMALES

Data expressed to the nearest hundredth of a year.

| Teeth | | 2nd Percentile | First Quartile ($Q_1$) | Median ($Q_2$) | Third Quartile ($Q_3$) | 98th Percentile |
|---|---|---|---|---|---|---|
| Max. | Mand. | | | | | |
| - | $di_1$ | 0.00 | 0.03 | 0.04 | 0.06 | 0.10 |
| $di_1$ | - | 0.01 | 0.03 | 0.05 | 0.07 | 0.11 |
| - | $di_2$ | 0.01 | 0.05 | 0.06 | 0.08 | 0.12 |
| $di_2$ | - | 0.04 | 0.08 | 0.10 | 0.12 | 0.18 |
| $dm_1$ | - | 0.12 | 0.16 | 0.18 | 0.20 | 0.27 |
| dc | - | 0.12 | 0.17 | 0.19 | 0.22 | 0.28 |
| - | $dm_1$ | 0.12 | 0.17 | 0.19 | 0.22 | 0.27 |
| - | dc | 0.12 | 0.17 | 0.20 | 0.23 | 0.30 |
| - | $dm_2$ | 0.28 | 0.34 | 0.37 | 0.42 | 0.49 |
| $dm_2$ | - | 0.30 | 0.37 | 0.42 | 0.46 | 0.55 |

TABLE IV

SKEWNESS AND SPREAD OF AGE DISTRIBUTIONS OF EMERGENCE AS SHOWN BY THE LIMITS OF THE MIDDLE 96 PER CENT OF THE DECIDUOUS TEETH OF MALES

Data expressed to the nearest hundredth of a year.

| Teeth | | Interval between Median and | | Total Interval Between 2nd and 98th Percentiles |
|---|---|---|---|---|
| Max. | Mand. | 2nd Percentile | 98th Percentile | |
| - | $di_1$ | 0.04 | 0.06 | 0.10 |
| $di_1$ | - | 0.05 | 0.06 | 0.11 |
| - | $di_2$ | 0.06 | 0.07 | 0.13 |
| $di_2$ | - | 0.07 | 0.07 | 0.14 |
| dc | - | 0.08 | 0.08 | 0.16 |
| - | dc | 0.08 | 0.08 | 0.16 |
| $dm_1$ | - | 0.07 | 0.08 | 0.15 |
| - | $dm_1$ | 0.07 | 0.07 | 0.14 |
| - | $dm_2$ | 0.10 | 0.12 | 0.22 |
| $dm_2$ | - | 0.12 | 0.14 | 0.26 |

TABLE V

SKEWNESS AND SPREAD OF AGE DISTRIBUTIONS OF EMERGENCE AS SHOWN BY THE LIMITS OF THE MIDDLE 96 PER CENT OF THE DECIDUOUS TEETH OF FEMALES

Data expressed to the nearest hundredth of a year.

| Teeth | | Interval between Median and | | Total Interval Between 2nd and 98th Percentiles |
|---|---|---|---|---|
| Max. | Mand. | 2nd Percentile | 98th Percentile | |
| - | $di_1$ | 0.04 | 0.06 | 0.10 |
| $di_1$ | - | 0.05 | 0.06 | 0.10 * |
| - | $di_2$ | 0.05 | 0.06 | 0.12 * |
| $di_2$ | - | 0.06 | 0.08 | 0.14 |
| $dm_1$ | - | 0.06 | 0.09 | 0.15 |
| dc | - | 0.07 | 0.09 | 0.16 |
| - | $dm_1$ | 0.07 | 0.08 | 0.15 |
| - | dc | 0.08 | 0.10 | 0.18 |
| - | $dm_2$ | 0.09 | 0.12 | 0.21 |
| $dm_2$ | - | 0.12 | 0.13 | 0.25 |

* Correct, although addition of first two figures on the same line makes the third one appear erroneous.

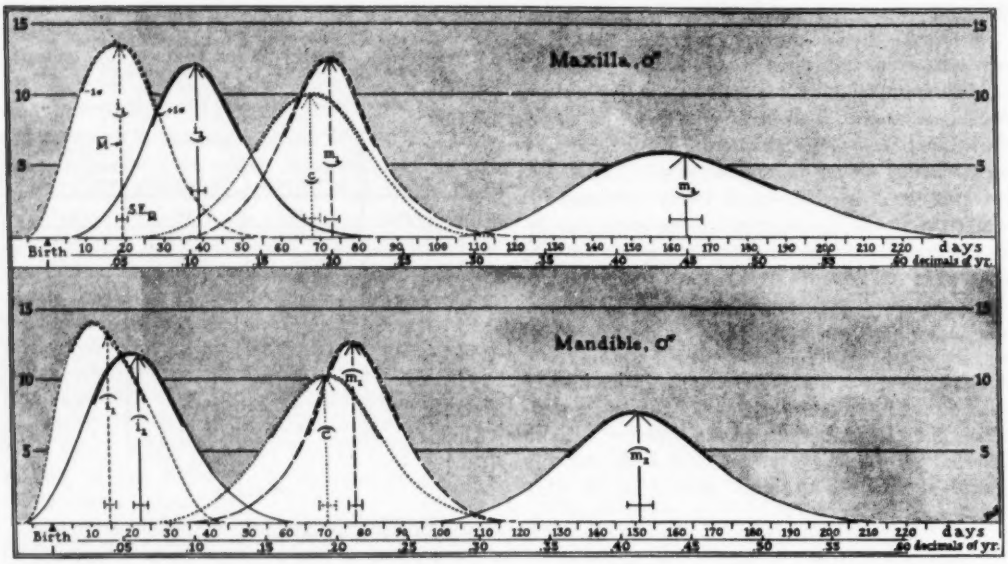


FIG. 3. A composite graphic representation of frequency distributions in the emergence of the deciduous teeth of male macaques (*Macaca mulatta*).

The limits of each individual curve indicate the approximate limits of the ranges of variability to be expected in an infinitely large population of similar animals reared in captivity. The mean age of emergence is indicated by a vertical arrow and the standard error of the mean by a short transverse line near the base of the arrow.

One sigma limits are shown by the double-line segment of a curve, which also helps to visualize the skewing of most frequency distributions. The mode, without special marking, is located at the peak of a curve. For an explanation of the significance of the long horizontal lines numbered 5, 10, and 15, see the text on page 299.

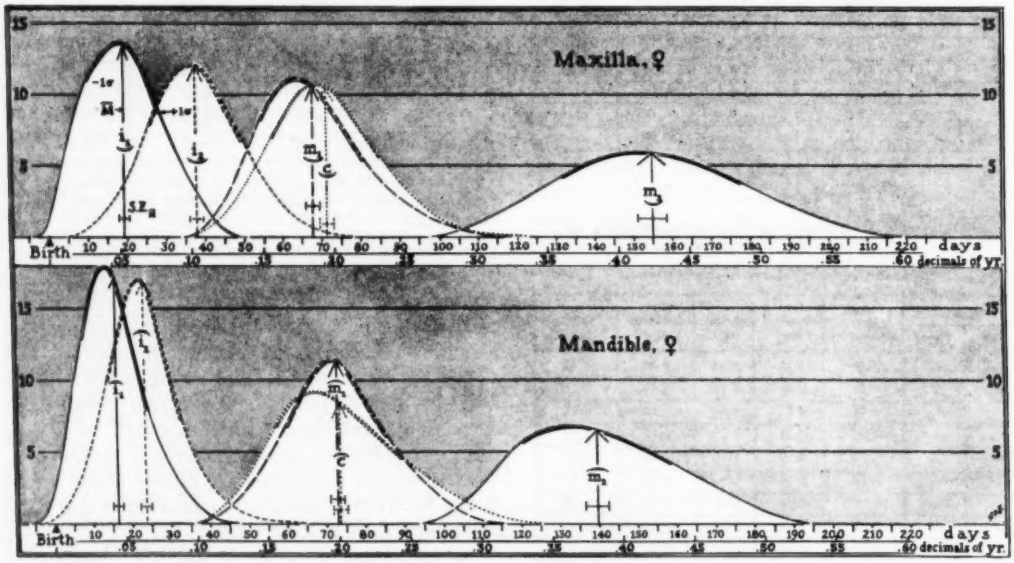


FIG. 4. A composite graphic representation of frequency distributions in the emergence of the deciduous teeth of female macaques (*Macaca mulatta*). For explanation of details, see text under figure 3.

and females, with the exception of the data for the second molars. It is also apparent that the skewness of most distributions is too slight to be expressed by the quartile coefficient of skewness, that is, by the formula $Sk=(Q_1+Q_3-2\ Q_2)/Q_3-Q_1$. It is not at all surprising, in view of the above, that Dahlberg and Maunsbach (4), in studying the eruption of teeth in Swedes, found "no appreciable difference . . . for the distance of the first and third quartiles from the median" and that they drew the conclusion that no noteworthy skewness existed in their material.

A better idea of the slight positive skewing present is given by the interpercentile ranges shown in tables IV and V. According to these tables the intervals between the median and the 98th percentile are generally 0.01 to 0.03 of a year greater than those between the median and the 2nd percentile. Since there are no exceptions to this rule, it appears permissible to conclude that the slight skewing, which the majority of the distributions present, is always in the positive direction. This finding confirms that previously found for human data by Okamoto (15), Robinow, Richards, and Anderson (18), Hurme (8), and Leslie (11).

The demonstration of minimal skewing of the frequency distributions made it apparent that the dispersion, or degree of variability, in the emergence of a given class of teeth could be expressed quite well by such common statistical measures as the mean and the standard deviation. This was done, using standard methods of direct computation, instead of probability paper, or some other indirect method. It was not assumed, *a priori*, that the computed means would be identical with the medians shown in tables IV and V.

The frequency values needed were obtained from the smoothed cumulative curves already described in detail. Age intervals of one-hundredth of a year were found convenient in deriving the relative frequencies at various age levels. The character of the frequency distributions, as determined with the above described technic, is shown by the graphs in figures 3 and 4. In these graphs the horizontal lines numbered 5, 10, and 15 have a two-fold purpose. The first is to help to bring out more clearly the differences in the heights of the various frequency curves. The second is to supply approximate numerical frequency values for each class of teeth in a random sample of 100 monkeys, when a hundredth of a year is utilized as the smallest unit measure of time.

Thus, referring to figure 3, it can be seen that in about 5 male animals out of 100 the maxillary first molar emerges at 0.24 of a year of age, and that the maxillary canine crown becomes visible in 10 out of 100 animals at 0.19 of a year. In the latter instance, since the peak of the curve reaches line 10 at a point almost directly above 0.19 of a year on the age scale, it can be said that 10 per cent of any large number of male macaques may be expected to show odontiasis of the maxillary canine at this age. In other words, the horizontal lines indicate the approximate percentages of the total monkey population which have tooth emergence during any given hundredth of a year.

Figures 3 and 4 also show, graphically, some of the numerical data given in tables VI and VII. The mean age of emergence of a tooth is shown by a vertical arrow, and the standard error of the mean (based on the number of tooth pairs[5]) by

TABLE VI

EMERGENCE OF DECIDUOUS TEETH OF MALE MONKEYS

All chronological data in decimals of a year, except where indicated otherwise.

| TEETH in Most Common Order of Emergence | | Number of Tooth Pairs Studied | Mean Age | S. D. of Mean | S. E. of Mean Based on Number of | |
|---|---|---|---|---|---|---|
| Maxilla | Mandible | | | | Teeth | Tooth Pairs |
| - | $di_1$ | 44 | 0.042 (15.24 d.) | 0.026 (9.42 d.) | 0.003 | 0.004 |
| $di_1$ | - | 44 | 0.052 (19.06 d.) | 0.027 (9.87 d.) | 0.003 | 0.004 |
| - | $di_2$ | 44 | 0.063 | 0.032 | 0.003 | 0.005 |
| $di_2$ | - | 44 | 0.106 | 0.033 | 0.004 | 0.005 |
| dc | - | 42 | 0.186 | 0.039 | 0.004 | 0.006 |
| - | dc | 41 | 0.194 | 0.039 | 0.004 | 0.006 |
| $dm_1$ | - | 41 | 0.200 | 0.033 | 0.004 | 0.005 |
| - | $dm_1$ | 41 | 0.214 | 0.034 | 0.004 | 0.005 |
| - | $dm_2$ | 33 | 0.415 | 0.052 | 0.006 | 0.009 |
| $dm_2$ | - | 32 | 0.450 | 0.065 | 0.008 | 0.011 |

TABLE VII

EMERGENCE OF DECIDUOUS TEETH OF FEMALE MONKEYS

All chronological data in decimals of a year, except where indicated otherwise.

| TEETH in Most Common Order of Emergence | | Number of Tooth Pairs Studied | Mean Age | S. D. of Mean | S. E. of Mean Based on Number of | |
|---|---|---|---|---|---|---|
| Maxilla | Mandible | | | | Teeth | Tooth Pairs |
| - | $di_1$ | 53 | 0.044 (15.96 d.) | 0.023 (8.35 d.) | 0.002 | 0.003 |
| $di_1$ | - | 53 | 0.053 (19.51 d.) | 0.026 (9.61 d.) | 0.003 | 0.004 |
| - | $di_2$ | 53 | 0.064 | 0.026 | 0.003 | 0.004 |
| $di_2$ | - | 53 | 0.104 | 0.033 | 0.003 | 0.005 |
| $dm_1$ | - | 50 | 0.185 | 0.037 | 0.004 | 0.005 |
| dc | - | 51 | 0.195 | 0.038 | 0.004 | 0.005 |
| - | $dm_1$ | 50 | 0.199 | 0.036 | 0.004 | 0.005 |
| - | dc | 51 | 0.201 | 0.044 | 0.004 | 0.006 |
| - | $dm_2$ | 43 | 0.382 | 0.053 | 0.006 | 0.008 |
| $dm_2$ | - | 44 | 0.424 | 0.063 | 0.007 | 0.010 |

[5] S.E. of mean, calculated on the basis of number of individual teeth, is somewhat smaller, as shown in tables

TABLE VIII

SEX DIFFERENCE BETWEEN MEAN AGES OF EMERGENCE

| TEETH in Order of Emergence Found for Males | | Males Earlier Than Females (yrs.) | Females Earlier Than Males (yrs.) | C. R. of Difference* | Interpretation |
|---|---|---|---|---|---|
| Maxilla | Mandible | | | | |
| - | $di_1$ | 0.002 | - | 0.4 | Insignificant |
| $di_1$ | - | 0.001 | - | 0.2 | |
| - | $di_2$ | 0.001 | - | 0.2 | |
| $di_2$ | - | - | 0.002 | 0.3 | |
| dc | - | 0.009 | - | 0.8 | Probably Insignificant |
| - | dc | 0.007 | - | 1.2 | |
| $dm_1$ | - | - | 0.015 | 2.1 | Probably Significant** |
| - | $dm_1$ | - | 0.015 | 2.1 | |
| - | $dm_2$ | - | 0.033 | 2.6 | |
| $dm_2$ | - | - | 0.026 | 1.8 | |

* Critical ratio of difference obtained by utilizing standard error of mean calculated on the basis of number of tooth pairs.

** The critical ratios for these four teeth are raised considerably (2.5–3.9) if calculated by using S.E's of mean based on the number of individual teeth.

a short transverse line near the base of the arrow. The limits of ± 1 S.D. are indicated by the portion of the curve drawn with a double line, which also serves to emphasize the asymmetry of many of the curves.

The ends of the curves indicate the approximate minima and maxima of the ranges of variability that are to be expected if an infinitely large number of animals were available for study. Since these limits are admittedly hypothetical and somewhat indefinite, the figures given in table XIII should be looked upon as tentative only.

Both figures 3 and 4, and the 2nd percentile values given in tables II and III, suggest that, if a very large number of rhesus monkeys is available for study, a few of them are likely to have the mandibular first and second incisors and the maxillary first incisors present at birth. The graphed and tabulated data also suggest that "natal teeth" are two or three times as common among males as among female macaques. Whether this peculiar sex difference exists in the human species is impossible to determine with certainty. The inadequate published accounts in scientific literature (12, 17) contain nothing that militates against the idea; the few newspaper reports seen by the authors happen to mention male infants only.

That teeth in the human newborn are relatively rare is conceded by all who have paid some attention to the phenomenon, but there seems to be no consensus regarding its frequency of occurrence. Estimates vary from 1 case in 2,000 births to 1 in 100,000. Among the *Macaca mulatta* about one baby out of a hundred appears destined to be born with one or more teeth in its oral cavity. The observations cited below lend considerable plausibility to the hypothetically completed end portions of the frequency distribution curves which extend to the left of the zero (or birth) points on the age scales in figures 3 and 4.

Out of the four series of 97 incisor tooth pairs studied in the course of this investigation, one and a half pairs—both mandibular first incisors and one maxillary first incisor—were present at birth in one male monkey (No. 484). In several other animals some of the mandibular first and second incisors and maxillary first incisors emerged within less than three days after birth. Although there were more data on females than males, the majority of teeth emerging very soon after birth were found in the male series.

The authors have data on natal teeth in 2 animals not included among the 97 dealt with in pre-

VI and VII. Since it is possible to argue that this figure is an understatement of the actual error, the larger figure, based on the number of tooth pairs, has been used.

paring the bulk of the statistical material presented in this paper. These 2 animals were males. One of them (No. 388), born in 1936, had both mandibular and both maxillary first incisors present at birth. In the second monkey (No. 793), born in 1952, after an exceptionally long gestation period, both mandibular first incisors had emerged into the oral cavity some time prior to birth.

Dual time scales under the graphs in figures 3 and 4 make it possible to read the age either in terms of days after birth, or in terms of decimals of a year. People working in laboratories and zoos generally prefer to designate age in terms of days, while biometricians find decimals of a year more convenient.

The differences between the mean ages of emergence for males and females are shown in table VIII. It is of interest to note that the males, considered collectively, have slightly earlier odontiasis than the females, if the molar teeth in both jaws are excepted. Calculation of critical ratios suggests that the lead of the females in the emergence of molars is significant in all probability. Further remarks about this semiautonomous behavior of incisor-canine and molar groups will be made in another connection.

A comparison of the medians in tables II and III with the corresponding means given in tables VI and VII reveals negligible differences for many teeth. In no instance do the differences amount to more than a hundredth of a year. One may conclude, therefore, that unless great accuracy is desired, it is permissible to treat these two measures of central tendency as identical, at least in studies on the eruption of deciduous teeth in the monkey. In more precise work it appears safe to assume that the median values are invariably slightly lower than the mean values. This, of course, is to be expected, in view of the slight positive skewness of most frequency distributions, a characteristic that has been demonstrated by several analysts (8, 11, 14, 15, 18).

The data available also enable one to test the usefulness of the formula,

$$\sigma = \frac{Q_3 - Q_1}{2 \times 0.6745},$$

for computing the standard deviation from incomplete percentile data, as Dahlberg and Maunsbach have done. The results obtained by using this formula prove that, in so far as the deciduous dentition of *Macaca mulatta* is concerned, there is very little difference between the values obtained by this indirect method and the standard method of computation. For only four teeth out of twenty was the difference as much as one-hundredth of a year. Although it may be dangerous to infer that the formula would be equally satisfactory in analyses of the eruption of permanent teeth, one may conclude that, where refinement is not of too great importance, it will not yield grossly erroneous figures.

TABLE IX

MODAL AND MEAN AGES OF EMERGENCE OF DECIDUOUS TEETH OF MACACA MULATTA

(All data in decimals of a year)

| Teeth in order of emergence found for males | | Modal ages | | Mean ages | |
|---|---|---|---|---|---|
| Maxilla | Mandible | Males | Females | Males | Females |
| — | $di_1$ | 0.033 | 0.038 | 0.042 | 0.044 |
| $di_1$ | — | 0.052 | 0.051 | 0.052 | 0.053 |
| — | $di_2$ | 0.059 | 0.061 | 0.063 | 0.064 |
| $di_2$ | — | 0.103 | 0.101 | 0.106 | 0.104 |
| dc | — | 0.187* | 0.190 | 0.186* | 0.195 |
| — | dc | 0.196* | 0.186 | 0.194* | 0.201 |
| $dm_1$ | — | 0.200 | 0.176 | 0.200 | 0.185 |
| — | $dm_1$ | 0.214 | 0.196 | 0.214 | 0.199 |
| — | $dm_2$ | 0.413 | 0.365 | 0.415 | 0.382 |
| $dm_2$ | — | 0.438 | 0.418 | 0.450 | 0.424 |

* Mean < mode.

A third measure of central tendency must be mentioned for the sake of completeness of presentation, namely, the mode. As is evident from figures 3 and 4, the modal values are, without significant exceptions, somewhat lower than the means. The only two reverse relationships can be found in the figures for males, which are based on fewer observations than the figures for females. Table IX gives the modal ages of emergence, as determined by the peaks of the distribution curves, together with corresponding mean ages.

For 82 out of the 97 animals included in the analyses just described the length of the period of intrauterine life is known. This circumstance provides a rare opportunity to examine the chronology of postnatal dental development from the standpoint of postconception age, or the total period of biological existence as an individual organism.

The most compelling reason for such a reexamination of the problem of tooth emergence is fur-

TABLE X

LENGTH OF GESTATION AND DEVIATION FROM THE MEAN IN THE EMERGENCE OF DECIDUOUS MAXILLARY TEETH IN TWO CONTRASTING GROUPS OF ANIMALS

| Class of teeth | Length of gestation period, in days | | | | Number of standard score units by which average for "short" group exceeds that for long gestation group |
|---|---|---|---|---|---|
| | Short: 156–163 | | Long: 175–180 | | |
| | Number of animals | Average standard score | Number of animals | Average standard score | |
| $di_1$ | 11 | +0.47 | 13 | −0.54 | 1.01 |
| $di_2$ | 11 | +0.77 | 13 | −0.30 | 1.07 |
| dc | 10 | +0.65 | 12 | −0.26 | 0.91 |
| $dm_1$ | 9 | +0.65 | 11 | +0.16 | 0.49 |
| $dm_2$ | 7 | +0.55 | 10 | +0.01 | 0.54 |

nished by the well known fact of considerable variability in the length of time required for gestation. For the 82 animals in the dental study the limits of the range of variation are 156 and 180 days, or 0.43 and 0.49 of a year. One animal (No. 793) not included in the group just mentioned was 184 days old, biologically, on the day of birth.

The average length of gestation for both male and female macaques of the species discussed in this paper is approximately 186.5 days, which corresponds to 0.46 of a year. The standard deviation of the mean, estimated from the data on 82 animals, is 5.2 days, or 0.014 of a year. These figures make it amply evident why one shou'd not assume, without direct proof, that the variability in the emergence of teeth is the same whether it is computed in terms of postnatal age or in terms of postconception age.

In order to get some idea of the possible influence of the length of gestation upon the time of eruption of teeth, the data were subjected to a special exploratory examination. Utilizing the original 97 dental records, a list was prepared showing all males and females with unusually short or long gestation periods. The plus and minus limits of one standard deviation were chosen as the arbitrary criteria for deciding what animals constituted the two samples wanted. Those with gestation periods of 163 days or less were designated as the end products of relatively short gestation, while those with a record of 175 days or more of intrauterine life were selected as representing long gestation periods. By combining the data for males and females it was possible to get 11 dental records of animals belonging to the first group and 13 records of animals representing the second group. For some classes of teeth the material available was somewhat less, being the least for the second molar, for which only 7 and 10 individual items could be obtained.

The postnatal ages of emergence for different maxillary teeth were converted into standard scores for the sake of convenience in comparing the emergence data for separate morphologic classes of teeth with each other. In effecting this conversion the postnatal biometric norms already computed (see tables VI and VII) were utilized. Teeth emerging one standard deviation earlier than the mean were given a standard score of − 1.00, those emerging half a standard deviation later than the mean received a standard score of + 0.50, and so on. After completing these determinations for each individual tooth pair, the average standard scores were calculated for each class of teeth for both the short and the long gestation groups. The results are summarized in table X.

According to the figures in table X there may be a definite negative correlation between the postnatal age of emergence of a deciduous tooth and the length of the gestation period. The shorter this period is, the later, in terms of age computed from the day of birth, are the teeth likely to appear through the gums. This conclusion was reached also by Nissen and Riesen (14) after analyzing their information on the dentition of the chimpanzee.

It is desirable, nevertheless, to take into account the considerable difference between the quantity of raw data analyzed by the above named investigators and that at the disposal of the present writers. Instead of observations on 16 animals, records on more than five times that number were available at Yale. By subjecting this larger body of material to a critical study, it has been possible to confirm the indications given by the exploratory examination already discussed, and, indirectly, to more than double the degree of confidence that can be placed in the conclusion drawn by Nissen and Riesen. Furthermore, the employment of a very dissimilar method of analysis has strengthened the feeling that the results obtained have not been the products of inadequate analytical procedures.

The initial step in examining the data on all 82 monkeys whose gestation ages were known consisted of arranging in order of increasing relative value the postnatal ages of emergence of all maxillary tooth pairs. The data on mandibular first incisors were included also, since these teeth are

the first to erupt in the "rhesus" monkey. The material on 40 males was listed separately from that on 42 females, so that any tendency to a differentiation between the sexes might be revealed.

The details of two of the rank order series are shown graphically by the histograms labeled "PN" in figures 7 and 8. The upper ends of the conjoined bars representing the postnatal ages of emergence of maxillary first incisors and canines form crude sigmoid curves, similar to those generally encountered in like arrays of most other biological measurements. The general characteristics of the series for the remaining ten teeth—four male and six female series, not illustrated here—were found comparable to the two chosen for illustration. To remind the reader of the "common foundation" which underlies all twelve secondary arrays of gestation data depicted in figures 5 and 6, an abstracted representation of a typical rank order histogram was added at the bottom of these two figures.

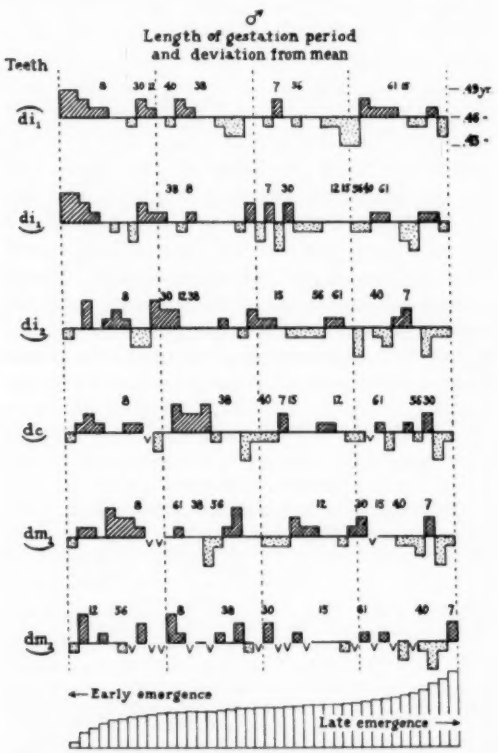


FIG. 5. Six histograms showing the relationship between length of gestation period and rank order of postnatal age at emergence of maxillary teeth and mandibular first incisor in 40 male macaques.

The identity of nine animals is indicated by numerals at appropriate locations over each histogram. $V$ = approximate location of missing datum.

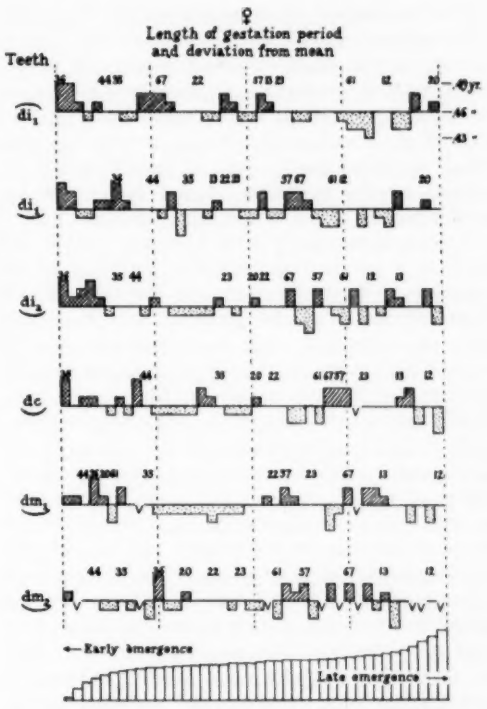


FIG. 6. Six histograms showing the relationship between length of gestation period and rank order of postnatal age at emergence of maxillary teeth and mandibular first incisor in 42 female macaques.

The identity of eleven animals is indicated by numerals at appropriate locations over each histogram. $V$ = approximate location of missing datum.

The second step consisted of listing, for each tooth pair, both the length of the gestation period and its deviation from the mean of 0.46 of a year, as computed for the monkey to whom the tooth pair belonged. Inasmuch as the relative rank order of animals was not exactly the same in each series, but depended upon the morphologic class of teeth under consideration, it was necessary to use the utmost care in preparing the tabulations which contained the information needed for constructing the bar graphs shown in figures 5 and 6. These graphs depict the gestation data corresponding to the serially arranged emergence data described in detail in the preceding two paragraphs.

The number of observations on the emergence of deciduous canines and molars was not equal to that on the incisors. Among males, the age of emergence of the maxillary canine was known for 38 animals out of 40 in the series and complete data on the maxillary second molar were available for 27 of this number. Among females, full information on the maxillary second molar was recorded for 33 out of a total of 42 animals.

Since the maxillary second molars are the last teeth to erupt in the deciduous dentition of the macaque, it seemed particularly desirable not to leave unconsidered the gestation age data that could be correlated with the dental data in this connection, in spite of the fact that proper integration of the shorter series with the longer ones proved rather problematical in preparing the histograms (figs. 5 and 6) and table XI. It could not be assumed, without examination, that the distribution of early, average, and late ages of emergence was as even, or well balanced, in the shorter series of data as in the longer. If the missing items belonged largely to one end or the other of a less extensive series, or if, by chance, they included many of the gestation values that deviated most markedly from the mean of 0.46 of a year, the results of searching for a possible correlation between length of gestation and postnatal age of emergence of the less adequately observed teeth would have been either deceptive or noninformative.

However, since it was known—as will be shown near the end of this paper—that there is a fairly high degree of individual consistency in the overall pattern of tooth eruption, it appeared feasible to locate the breaks, or hiatuses, in a given rank array of emergence data by referring to the more complete series immediately preceding. Thus, in preparing the maxillary canine histogram in figure 5, it was found that there was no information on the emergence of this tooth in two animals, No. 44 and No. 43 (numbers not shown in figure 5), for which incisor data had been obtained. The bar indicating a gestation period of 0.44 of a year, or a minus deviation of 0.02 of a year, for animal No. 44 is the ninth one from the left in the maxillary second incisor series. The gestation age (0.46 yr., or no plus or minus deviation) for animal No. 43 is shown by the thirty-first item in the same series. The breaks in the canine line were, therefore, placed in the ninth and thirty-first divisions of the line. As there were no first and second molar data, either, for the two males just mentioned, the breaks in the continuity of the two molar histograms below were similarly located. To make the discontinuous portions of the 0.46 yr.-lines more conspicuous, a "V" was added at every break, just below the level of the lines.

A still more accurate determination of the location of each hiatus could have been attempted by referring to every series not lacking dental data for the animal under consideration and then computing an average from all rank values found. Such refinement seemed unnecessary for the purposes of the present investigation. It was felt that even though the technic employed may have resulted in a few errors, none of these was of such magnitude as to justify the expenditure of time and effort required by adopting a more elaborate method of procedure.

To facilitate study of the details recorded in graphic form in figures 5 and 6, vertical lines were added so as to divide each diagram into four equal parts, although division into some other small number of parts might have served as well. It is quite evident, without formal tabulation of numerical values, that, in a general sense, there is a contrast between the two halves of each figure, and an even stronger contrast between the first and last quarters. The one possible exception to this general rule is furnished by the maxillary second molar of females, but the aggregation of missing items in the second half of the series indicates the need for caution in interpreting this particular histogram. The corresponding diagram for males shows a fairly even distribution of breaks in the

TABLE XI

NUMERICAL SUMMARY OF GRAPHED DATA IN FIGURES 5 AND 6

(Average length of gestation period in each quarter of a series.)

| Teeth | | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quarters | | | | Quarters | | | |
| | | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| Mand. | $di_1$ | 47.2 | 45.7 | 45.5 | 45.9 | 46.8 | 46.4 | 46.0 | 45.2 |
| Max. | $di_1$ | 46.9 | 46.2 | 45.6 | 45.6 | 46.9 | 45.8 | 45.9 | 45.9 |
| Max. | $di_2$ | 46.5 | 46.6 | 46.0 | 45.2 | 46.9 | 46.6 | 45.9 | 46.1 |
| Max. | dc | 46.1 | 46.5 | 46.1 | 45.6 | 46.7 | 45.6 | 46.0 | 46.1 |
| Max. | $dm_1$ | 46.5 | 46.1 | 46.1 | 45.6 | 46.9 | 45.0 | 46.1 | 46.4 |
| Max. | $dm_2$ | 46.2 | 46.3 | 46.2 | 45.6 | 46.2 | 45.9 | 46.3 | 46.0 |
| Averages for all 6 teeth | | 46.6 | 46.2 | 45.9 | 45.6 | 46.7 | 45.7 | 46.0 | 45.9 |

series from one quarter to another and a good conformity to the general pattern mentioned above.

Table XI elucidates further the general trends revealed by the histograms. The numerical averages given for each quarter of a dental series corroborate the conclusions drawn from a visual inspection of figures 5 and 6. For both males and females, the average length of the gestation period is greater for the animals in the first quarter of a dental series than for those in the last quarter, in all twelve series considered. Yet it is apparent that the contrasts are greater for all classes of teeth among the males than among the females, both collectively and on the basis of subgroups. Also, it is of interest to note that, in both sexes, the contrasts steadily diminish as one proceeds from the mandibular first incisor, which is the first tooth to emerge, to the maxillary second molar, which is the last to take its place in the dental arches. This observation suggests that there is a degree of validity in the "dentition factor" hypothesis postulated by Robinow, Richards, and Anderson, who, by means of factor analysis, found closer relations between incisors and canines than between incisors and molars. Reference to this "dentition factor" was made earlier, in discussing the sex differences between the emergence ages.

The general character of both numerical and graphed gestation data makes it obvious that there would be little or no real gain from computing rank order correlation coefficients between postnatal eruption ages and gestation ages, even though it is clear that moderately high negative coefficients would be obtained. Of much greater practical usefulness are the simple observations that an unusually long gestation period is very likely to result in early (or earlier-than-average) postnatal emergence of the teeth, regardless of their anatomical designation, and that, conversely, late postnatal emergence of teeth quite definitely rules out the probability of a longer-than-average period of intrauterine life. Similarly, very early eruption of teeth is not associated with a very short gestation age, in spite of the fact that an unusually brief gestation period may be followed by eruption of teeth quite within the range of the average.

The existence of a degree of negative correlation between length of gestation and postnatal age of tooth emergence raises the question whether the standard deviations presented in tables VI and VII coincide with those computed from postconception ages of tooth emergence. Since it already has been shown that taking into account the length of the gestation period tends to equalize some of the very early and very late postnatal emergence ages, it cannot be taken for granted, without direct evidence, that such equalization of extremes does not also mean smaller degrees of variability for emergence ages expressed in terms of postconception intervals of time. In other words, one may expect to obtain somewhat smaller standard deviations of the mean than are shown in tables VI and VII by basing all calculations upon postconception ages of tooth emergence.

To test this hypothesis the postnatal emergence ages for the five maxillary tooth pairs of the 40 males and 42 females mentioned earlier were converted into postconception ages of emergence by adding appropriate gestation ages to the original figures. The resultant data were treated in the same manner as in previous calculations for finding the standard deviations of the mean. The outcome of this effort was somewhat of a surprise: the standard deviations obtained differed scarcely at all from those calculated earlier. In none of the ten separate instances was the difference as much as one hundredth of a year; in fact, many values were only about three thousandths of a year apart. No need was seen for subjecting the data on mandibular teeth to a similar check.

The conversion of postnatal ages into postconception ages had resulted in many shifts in the rank order of individual items in each series. Since the number of plus and minus deviations about the mean in each gestation age array was approximately the same, it was to be expected that the number of increases was almost equal to that of decreases in a converted emergence age series. What could not be expected with confidence was the stability in the general character of variability, as expressed by cumulative frequency curves and frequency distribution data in numerical form. Even the end portions of these curves had remained surprisingly stable, although the most marked deviations from the mean in each gestation age array generally favored the end portions of each series, rather than the midsection. (See figs. 5 and 6.) Considered collectively, the increases and decreases in the magnitude of various individual components had not caused the expected contractions in the ranges of variability. Postconception emergence ages yielded the same standard deviations as postnatal emergence ages, as stated earlier.

Figures 7 and 8 were drawn to show why, after careful consideration of pertinent details, the near

equality of standard deviations calculated from the two kinds of age data should have been anticipated. In figure 7 the postnatal emergence data for the maxillary first incisors of 40 male monkeys have been arranged in a sequence based on increasing numerical values, which are shown in section "PN" of the figure by the heavy continuous line rising stepwise from left to right. The gestation data corresponding to the emergence data just mentioned are supplied by histogram "GES," wherein the same sequence is observed as in series "PN." The rank order of individual items in both of these arrays is revealed by referring to numerals and symbols in section "ID."

The orderly sequence of postconception emergence ages for the same animals is presented in section "PC." Since the rank order of values for individual animals is not the same in this series as in the first two ("PN" and "GES") shown in figure 7, a second listing of identification symbols and numerals is required. This is furnished by the second "ID" zone at the bottom of the figure.

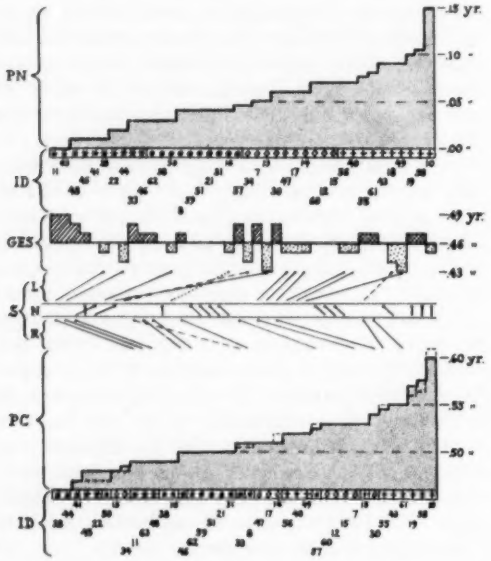


FIG. 7. Graphic representation of interrelationships between data on emergence of maxillary first incisors and length of gestation of 40 male macaques.

Explanation of abbreviations:

PN—Postnatal ages of emergence, arranged in order of increasing numerical value. The heavy, step-like line is formed by the upper ends of contiguous bars, the heights of which give the ages of emergence for 40 tooth pairs.

ID—Identification of individual animals furnishing the data in histograms "PN," "GES," and "PC." Each animal is identified by a numeral and a symbol. The four groups of symbols divide the data in the "PN" and "GES" series into four equal parts.

GES—Length of gestation periods for the animals in the postnatal emergence series ("PN") above. This histogram is identical with the second one from the top in figure 5.

S—Shifts of individual items in series "PN," after conversion into postconception ages and arrangement in order of increasing numerical value. Subdivisions "L" and "R" indicate shifts to the left and right, respectively, while "N" indicates relatively stationary items.

PC—Postconception ages of emergence, arranged in rank order. The heavy continuous line gives the postconception ages and the light broken line represents a superimposition of the postnatal ("PN") emergence age histogram upon the postconception series.

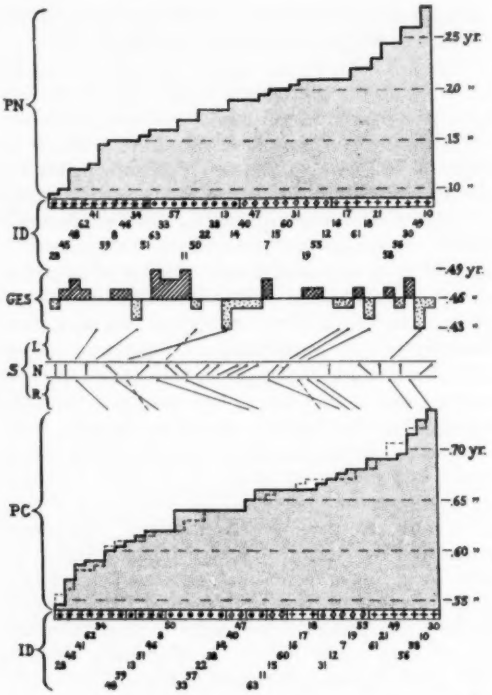


FIG. 8. Graphic representation of interrelationships between data on emergence of maxillary canines and length of gestation of 38 male macaques.

For explanation of abbreviations see text under figure 7. The second and third groups of symbols in sections "ID" comprise nine items each, instead of ten as in figure 7. Histogram "GES" is identical with the fourth one in figure 5.

By noting the arrangement of numerals and symbols in this section one can appreciate the amount of redistribution necessary to convert rank order array "PN" into sequence "PC."

That the original "PN" series has been only partially fragmented in the process of conversion is readily seen. The four groups of ten symbols each indicate this particularly well; the general character of the original symbol sequence is still evident in the "PC" series, wherein many individual items remain in the same, or nearly same, positions as in the first ("PN") series. An examination of the identifying numerals, of course, leads to the same conclusion.

Another means of gaining a helpful visual impression of the positional changes among the components of the two rank arrays just discussed is provided by a study of the lines drawn in section "S" of figure 7. The angles and lengths of the lines in the three horizontal subdivisions of this section describe the directions and comparative amounts of the individual shifts in the series. Subdivision "N" of section "S" contains 15 short, vertical, or nearly vertical lines. These represent postnatal emergence ages which remained in virtually unchanged locations in the postconception emergence series. (This number is 4 more than the 11 neutral values among the gestation ages of the group.) Subdivision "L" shows that 13 individual items were shifted to new positions more or less markedly to the left of their original places in series "PN." Twelve items were shifted similarly to the right, as shown by subdivision "R," although the number of positive deviations—15—among the gestation ages was slightly more.

Section "PC" of figure 7 also shows a broken line histogram superimposed upon the one indicated by the heavy continuous line. The first mentioned line represents the values shown in the "PN" series above and the purpose of the superimposition is to give one more illustration of the close similarity between the degrees of variation exhibited by the values in the two series under consideration.

Figure 8 requires little special explanation. The reader can perceive quite readily that it is a counterpart of figure 7, designed to illustrate the minutiae of the data on the maxillary canines of 38 male macaques. In a general sense, the graphic summarization of these data shows a close parallelism with the maxillary incisor data recorded in figure 7.

One or two points of dissimilarity between figures 7 and 8 warrant some comment. By comparing the sections labeled "S" in the two figures, it is evident that the amount of rearrangement necessary to produce series "PC" out of series "PN" is considerably less when dealing with the maxillary canine data than when dealing with the first incisor material. The number of items in subdivision "N" of section "S" in figure 8 is 19, or one half of the total; in the case of the incisor tooth data just referred to it is 37.5 per cent of the total. On the other hand, the proportion of items in subdivisions "L" and "R" is smaller in the canine series and the obliquity of the lines indicates somewhat less transposition of individual items than in the incisor series. Furthermore, the fragmentation of the four symbol groups in the second "ID" section of figure 8 is much less than that in the corresponding section of figure 7, as would be expected after comparing the patterns of the lines in sections "S."

The observations just made confirm what can be expected on the basis of a consideration of the ranges of dispersion as one proceeds from first incisor data to statistical material on teeth which emerge later. As the mean ages of emergence become higher and the ranges of variability (expressed by standard deviations) expand, the conversion of postnatal ages of emergence into postconception ages causes progressively less alteration in the rank order of individual component items.

TABLE XII

RELATIVE VARIABILITY OF FREQUENCY DISTRIBUTIONS DESCRIBING THE EMERGENCE OF DECIDUOUS TEETH IN *Macaca mulatta*

(Postconception ages of emergence were utilized in all calculations.)

| Teeth in order of emergence found for males | | Coefficient of variation (per cent) | |
|---|---|---|---|
| Maxilla | Mandible | Males | Females |
| — | $di_1$ | 5.2 | 4.6 |
| $di_1$ | — | 5.3 | 5.1 |
| — | $di_2$ | 6.2 | 5.0 |
| $di_2$ | — | 5.8 | 5.9 |
| dc | — | 6.0 | 5.8 |
| — | dc | 6.0 | 6.7 |
| $dm_1$ | — | 5.0 | 5.7 |
| — | $dm_1$ | 5.1 | 5.5 |
| — | $dm_2$ | 5.8 | 6.3 |
| $dm_2$ | — | 7.1 | 7.2 |

The establishment of the validity of the standard deviations shown in tables VI and VII makes it profitable to compute the coefficients of variation for the deciduous dentition of *Macaca mulatta*. Utilizing the means of the postnatal emergence ages for this purpose would have yielded meaningless and deceptive percentages for many teeth, in view of the fact that some of them, like the incisors, emerge soon after birth. A percentage of 61.9 for the mandibular first incisor and of 14.4 for the maxillary second molar of the male certainly give one the impression that the first mentioned tooth is about four times as variable as the other. To overcome this difficulty the mean values of post-conception ages of emergence were employed. The results are given in table XII.

Inspection of the percentage values in this table reveals at once the greater relative variability of the maxillary second molar, when it is compared with the mandibular first incisor. In fact, on the basis of the values tabulated, the maxillary second molar is the most variable tooth in both sexes. In the males, the first molars are the least variable; among the females, the first incisors and the mandibular second incisor. In each jaw, in both males and females, the second incisors are more variable than the first incisors.

An additional generalization can be made. The emergence of the teeth of males seems to be slightly more variable than that of the females in early infancy. Later, when the molars are taking their places in the dental arches, this relationship reverses itself and the females seem more variable. This observation again reminds one of the "dentition factor" of Robinow, Richards, and Anderson, and adds one more fact in favor of their hypothetical concept. It is, nevertheless, necessary to remark that the above named authors did not find all of the anatomical parallels and contrasts that the present writers did between the coefficients of variation calculated from their material; apparently the regional, or tooth group, associations are much more pronounced in the monkey than in man. Another interspecies difference is furnished by the second incisors, which in the monkey are much less variable than they are in human populations.

Individual consistency in rate of dental develop-

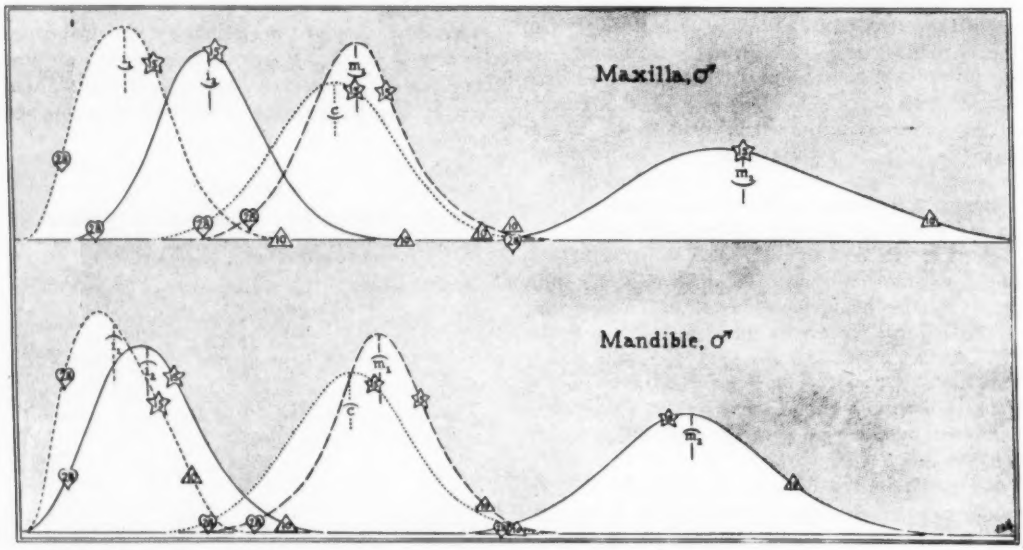


FIG. 9. The chronologic pattern of emergence of the deciduous teeth in three male macaques, one of which had very early eruption of the maxillary second molar (No. 28), while in the second monkey this tooth pair appeared when expected (No. 15) and in the third much later than usual (No. 10).

The relative order of postnatal emergence ages is indicated by numbers within readily identified symbols, located at appropriate places along the curves which represent hypothetical frequency distributions. These curves are identical with those depicted in figure 3. Short vertical lines near peaks of curves indicate mean ages of emergence.

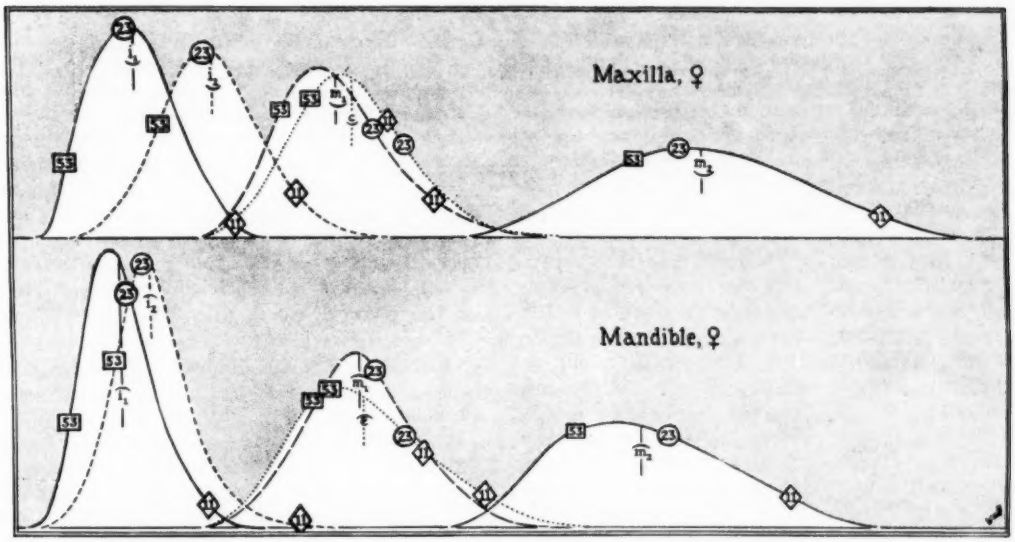


FIG. 10. The chronologic pattern of emergence of the deciduous teeth in three female macaques, one of which had rather early eruption of the maxillary first incisor (No. 53), while in the second monkey this tooth pair appeared when expected (No. 23) and in the third much later than usual (No. 11).

For further explanation see text under figure 9. The curves depicted are the same as those shown in figure 4.

ment was investigated also, but less thoroughly than other aspects of odontiasis, or tooth emergence. By studying the placement of the nine identifying numerals above the histograms in figure 5 and the eleven numerals in figure 6 the reader can prove to himself that most animals follow, rather consistently, a developmental schedule that is reasonably fixed during the 3 to 7 month period required to complete the emergence process. Odontiasis commencing early is likely to be finished early, and *vice versa*. But, as might be expected of any biological process, there are "exceptions which prove the rule." In figure 6, for example, the teeth of monkey No. 20 exhibit most erratic behavior, as shown by the numeral appearing in all quadrants of the total series.

Figures 5 and 6 furnish two other useful hints to clinical and laboratory workers. The first of these is that one should never expect to determine the probable rate of dental development in a given animal by establishing the emergence ages of only one or two individual teeth; observations on a minimum of three or four teeth are necessary for a rough approximation. The second is that the first teeth to emerge—the first incisors—are likely to give somewhat poorer clues of the speed of dentition than some of the other teeth.

In order to examine this problem from a different angle, the emergence ages of all ten tooth pairs in six animals were plotted against the background of frequency distributions shown graphically in figures 3 and 4. The monkeys represented in figure 9 were selected at random to provide examples of males with early, average and late emergence of the maxillary second molars, while those in figure 10 were selected to represent the emergence of the maxillary first incisors of female monkeys at a relatively early, average, and late postnatal age.

The sequence of numbers within the symbols is the same for all ten classes of teeth, as shown graphically in figure 9. Even the intervals between the symbols are almost the same in each instance. Figure 10, on the other hand, reveals one imperfection in the prevalent pattern: the order of symbols on the maxillary canine line is No. 53, No. 11, and No. 23, instead of No. 53, No. 23, and No. 11, as on all other graphs. Moreover, the intervals between the symbols are somewhat less regular. It can be said that figure 10 lends strength to the assertion that the prognostic value of an emerging first incisor is poorer than that of some other tooth.

There is a small amount of evidence from other

TABLE XIII

AGE RANGES AND AVERAGE AGES OF EMERGENCE FROM DATA OF THREE SEPARATE STUDIES OF MACAQUES

Averages represent midvalues for males and females. Minima and maxima are from tabulations or graphs on either sex. Data from reports by Schultz and Spiegel have been converted into decimals of a year. Figures from their studies diverging most markedly from those in the third, fourth, and fifth columns have been placed inside blocks.

| Teeth | | Present study (*Macaca mulatta*) | | | Schultz (*Macaca mulatta*) | | | Spiegel (*Macaca irus mordax*) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Max. | Mand. | Min. | Aver. | Max. | Min. | Aver. | Max. | Min. | Aver. | Max. |
| — | $di_1$ | −.02 | .04 | .13 | .00 | .05 | .10 | .02 | .04 | .07 |
| $di_1$ | — | −.02 | .05 | .15 | .02 | .06 | .10 | .02 | .05 | .08 |
| — | $di_2$ | −.02 | .06 | .18 | .04 | .08 | .13 | .04 | .07 | .09 |
| $di_2$ | — | .01 | .11 | .23 | .06 | .12 | .13 | .07 | .11 | .15 |
| dc | — | .06 | .19 | .34 | .15 | .24 | .31 | .16 | .25 (or .22)* | .47 |
| $dm_1$ | — | .09 | .19 | .33 | .19 | .27 | .37 | .11 | .19 | .27 |
| — | dc | .07 | .20 | .35 | .15 | .27 | .33 | .16 | .25 (or .22) | .51 |
| — | $dm_1$ | .09 | .21 | .33 | .15 | .26 | .35 | .14 | .19 | .25 |
| — | $dm_2$ | .25 | .40 | .58 | .29 | .44 | .56 | .35 | .46 (or .45) | .69 |
| $dm_2$ | — | .26 | .44 | .65 | .31 | .48 | .62 | .35 | .48 (or .40) | .77 |

* Decimal equivalent for Spiegel's uncorrected average.

sources that confirms the existence of readily detectable degrees of individual consistency in rates of dental development. Nissen and Riesen analyzed the rank orders of "average eruption ages" of 16 young chimpanzees and Spiegel published, in full, but without comment, his original figures on 12 infant macaques. Unpublished data by one of the authors of this paper (V. O. H.) reveal corroborative trends in the permanent dentitions of a large group of subadult human subjects. Doering and Allen, by correlating the age at which the first deciduous tooth was present with the age at which the twentieth tooth appeared, obtained coefficients which indicated that "the process of dentition takes place at an earlier age in some children than in others."

It may seem trite to say that the teeth of each individual must possess a common aggregate of certain genetic, physiologic, and environmental determinants during the many months, or years, of odontiasis. It may be less trite to assert that were these common factor complexes not rather securely interlinked, like the separate links of a strong chain, or as orderly as the different phases of a chemical chain reaction, there would be little or no uniformity in the sequence of emergence of different teeth. Characteristic species and sex differences would not exist. Individual inconsistency in the rate of dental development and various types of malocclusion would be the rule in all dentate creatures.

Considered together, as they certainly should be considered, the high degrees of individual consistency and the wide ranges of variation, which have been discussed at length in this paper, suggest that slight increases or decreases in the rate of operation of the physiologic processes which underlie dental growth and development cannot break or alter the factor linkages hypothesized above. (The word "slight," in this context, should be interpreted as a multiplyer or divider that is greater than 1, but smaller than 1.7.) Haphazard sequences of eruption, and malocclusions, do not characterize the 97 presumably normal monkeys, whose dental records serve as the core of this study. As a corollary to the theorem sketched above, one may also state that, once a certain rate of developmental changes has been established in a given individual, it is not readily or greatly altered. All of this results in biometrically demon-

strable patterns of uniformity in the emergence of teeth in the majority of a group.

Before concluding the analyses which are the primary subject of this paper, an effort was made to find out exactly how well some of the new material here presented harmonizes with the data published by others. Since the most important reports in the literature dealing with the development of deciduous dentitions in macaques are those by Schultz (21) and Spiegel (26), comparisons between the newer and older data became a relatively simple matter. Although the study of Spiegel deals with a different species of macaques than the one considered in this paper, it appeared worth while not to omit listing his figures with those obtained for the "rhesus" monkey (*Macaca mulatta*).

Table XIII brings together certain chronological values from the present study and from the two reports mentioned above. The selection of average ages and age ranges of emergence for tabulation is due to the fact that they can be obtained from all three sources, besides being suitable for a comparative study. The data of Schultz, originally in terms of weeks, and those of Spiegel, in terms of days, were converted into decimals of a year, the form in which most of the chronological material in this paper is presented.

Spiegel's own averages for the canines and second molars are not arithmetically correct, if the detailed figures, as printed in his report, are not erroneous. Since these discrepancies cannot be cleared up today, it was decided to include Spiegel's questionable averages also in table XIII, where they appear in decimal form, within parentheses.

The similarity between the "tentative averages" of Schultz and the averages obtained from the present analyses is surprisingly good. The only conspicuously dissimilar age value in the series of averages under his name is that for the maxillary first molar; the age range for this tooth is likewise out of harmony with those obtained from the present study and from the study by Spiegel. When it is recalled that the criterion of tooth emergence employed by Schultz differs from that generally accepted, it is to be expected that his averages would be somewhat higher than those obtained by others for *Macaca mulatta*.

With two exceptions, the upper limits of the age ranges, as determined by Schultz, fall below the maxima given in the fifth column. The exceptionally high figure for the maxillary first molar is difficult to explain. Part of the excess over 0.33 yr. can be accounted for by making allowance for the different criterion of emergence. Part of it may be due to too wide spacing of the examinations of teeth by Schultz. The third possibility, of course, is that the maximum established by the present investigators is too low, if their series of 97 animals was not large enough to include some examples of very late eruption of teeth. This does not seem too likely. A fourth possibility is that one of Schultz's specimens had some developmental abnormality, which resulted in retarded emergence of one or both maxillary first molars.

The different methods used for determining the ranges of variation, together with the much larger number of specimens available for examination at Yale, readily accounts for the wider age ranges obtained by the present authors. The fact that, with only two inconclusive exceptions, they definitely overlap those of Schultz at both ends of each range can be taken as an indication of their probable reliability.

Table XIII also confirms the generally held view that the sequence of tooth emergence is, as a rule, quite uniform for the incisors and second molars, but variable for the canines and first molars.

The averages by Spiegel for *Macaca irus mordax* are astonishingly similar to those obtained for *Macaca mulatta*. The age ranges, too, except for four maxima which exceed those of Hurme and van Wagenen, are not remarkably different from those established for the latter species. These observations lead to the conclusion that until more precise biometric norms have been worked out for *Macaca irus mordax*, the norms calculated for the rhesus macaque may be used in a tentative manner in dealing with *Macaca irus mordax*.

The sum total of factual information accumulated in the course of this investigation enables one to make a few definite, unqualified statements about the usefulness of teeth as a criterion of chronologic age. First of all, it is quite clear that attempts to "age" a monkey with an unknown birth date by relying on a single examination of its dentition is a very poor substitute for properly spaced repeat examinations made after the acquisition of the animal. At best, a single dental inspection can furnish a relatively crude estimate of age, which is always conditioned by the extremes of the ranges of variation established for the different classes of teeth. That the limits of the ranges of dispersion are inconveniently far apart for accurate estimations of age is obvious from a perusal of figures 3 and 4, or from a study of the minima and

maxima in the first and third columns of table XIII. The 2nd and 98th percentiles in tables II and III likewise illustrate the magnitude of the degrees of dispersion.

A single examination, and a reference to appropriate biometric norms, can furnish an estimate that is largely, but not entirely, circumscribed by the limits of the range of variation existing for the class of teeth represented by the most recently added member of the dentition. (It is usually possible to say what this tooth is.) The estimate can be slightly improved in many cases by making certain corrections discussed below.

If the crowns of all deciduous teeth, except those of the maxillary second molars, are visible above the gingivae of a given monkey, a male, let us say, reference to the age scale and the frequency distribution curve for the *mandibular* second molar in figure 3 supplies the information that the age of the animal is between 0.26 and 0.58 of a year, or 95 and 213 days. These are the approximate extremes of the curve in the figure.

The 2nd and 98th percentiles should serve very well in most estimations of the age of a young monkey, since in only 4 per cent of the cases odontiasis occurs outside these limits. However, if other physical considerations, such as sitting height, weight, bone age, etc., indicate that the animal may be very near either of these limits, it would appear best not to estimate its age with the aid of these percentiles.

Use of table II in the preceding example places the age of the hypothetical monkey between 0.31 and 0.52 of a year, that is, 112 and 191 days. This is a considerably narrower time span than the one obtained by referring to figure 3.

If the macaque under consideration happens to exhibit clearly asymmetrical emergence of the mandibular second molars, slightly narrower age limits can be obtained even with the aid of figure 3. Since it is self-evident that if the first tooth of a pair should emerge at a moment that coincides with the hypothetical minimum age, then the antimere must come through the mucoperiosteum a short time later—both teeth cannot occupy the same point on the age scale. Conversely, the earlier member of a pair cannot emerge at the maximum age shown by the graph, whereas the later member can. Therefore, whether one uses figure 3 or table II in estimating the age of a male animal with asymmetrical eruption, he may add 0.01 or 0.02 of a year to the minimum age figure and subtract a like amount from the maximum figure. Furthermore, if he reexamined the animal at least once, 10 to 12 days after the initial examination, he might find himself entitled to a correction of $2 \times 0.03$ of a year.

It may be of value to note, parenthetically, that the greatest degrees of asymmetry recorded for any deciduous tooth in the entire group of 97 normal animals are two instances of 0.06 of a year and one of 0.07 of a year. One of Spiegel's tabulations records a 0.08 of a year difference between the emergence dates of deciduous mandibular canines in one macaque.

Even in the absence of asymmetrical emergence some improvement of an age estimate based on a single dental examination is possible. Referring once more to the imaginary male macaque with no visible maxillary second molars (see above), it may be pointed out that since the minimum age at which these teeth are expected is about 0.29 year, or 105 days, according to figure 3, the earlier minimum of 0.26 year, or 95 days, can be safely discarded. If table II is used in making the estimate, the minimum may be raised from 0.31 to 0.33 year, or from 112 to 119 days.

To recapitulate, assuming that the monkey appeared "safe" for utilizing table II, and that it had moderate asymmetry (0.02 yr.) in the emergence of the mandibular second molars, the final limits of the estimated age would be 0.33 and 0.50 year, or 119 and 184 days. The original estimate would be improved by 0.04 year, or 14 days, which is not a negligible span of time in the life of a small infant macaque.

For a more accurate determination of the age of a baby monkey, whose birth date is unknown, but whose deciduous dentition is still incomplete, it is absolutely necessary to keep weekly, or semi-weekly, records on the emergence of teeth not present for direct visual examination at the time the animal was acquired. If such records can be secured for one-half, or more, of the milk dentition, it should be possible to ascertain the postnatal age of the animal with rather narrow margins of error. It is hardly necesary to add that in all estimations of age the sex of the subject should not be ignored.

The idea just presented was put to test twice. In both trials a selection was made from the complete dental records in the series of 97 used for several calculations—only the identity and the birth date were kept secret until the work on preparing the two estimates of age was completed.

## TABLE XIV

CONVERSION OF DAYS INTO HUNDREDTHS OF A YEAR AND VICE VERSA

(The nearest decimal equivalent for a given number of days is indicated)

| days | year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .00 | 61 | | 123 | | 185 | | 244 | | 305 | | |
| | | 62 | .17 | 124 | .34 | 186 | .51 | 245 | .67 | 306 | .84 | |
| | | 63 | | 125 | | 187 | | 246 | | 307 | | |
| 2 | | 64 | | 126 | | 188 | | 247 | | 308 | | |
| 3 | .01 | 65 | .18 | 127 | .35 | 189 | .52 | 248 | .68 | 309 | | |
| 4 | | 66 | | 128 | | 190 | | 249 | | 310 | .85 | |
| 5 | | 67 | | 129 | | 191 | | 250 | | 311 | | |
| 6 | | 68 | | 130 | | 192 | | 251 | | 312 | | |
| 7 | .02 | 69 | .19 | 131 | .36 | 193 | .53 | 252 | .69 | 313 | | |
| 8 | | 70 | | 132 | | 194 | | 253 | | 314 | .86 | |
| 9 | | 71 | | 133 | | 195 | | 254 | | 315 | | |
| 10 | | 72 | | 134 | | 196 | | 255 | .70 | 316 | | |
| 11 | .03 | 73 | .20 | 135 | .37 | 197 | .54 | 256 | | 317 | .87 | |
| 12 | | 74 | | 136 | | 198 | | 257 | | 318 | | |
| 13 | | 75 | | 137 | | 199 | | 258 | | 319 | | |
| 14 | .04 | 76 | .21 | 138 | .38 | 200 | .55 | 259 | .71 | 320 | | |
| 15 | | 77 | | 139 | | 201 | | 260 | | 321 | .88 | |
| 16 | | 78 | | 140 | | 202 | | 261 | | 322 | | |
| 17 | | 79 | | 141 | | 203 | | 262 | .72 | 323 | | |
| 18 | .05 | 80 | .22 | 142 | .39 | 204 | .56 | 263 | | 324 | | |
| 19 | | 81 | | 143 | | 205 | | 264 | | 325 | .89 | |
| 20 | | 82 | | 144 | | 206. | | 265 | | 326 | | |
| 21 | | 83 | | 145 | | 207 | | 266 | .73 | 327 | | |
| 22 | .06 | 84 | .23 | 146 | .40 | 208 | .57 | 267 | | 328 | .90 | |
| 23 | | 85 | | 147 | | 209 | | 268 | | 329 | | |
| 24 | | 86 | | 148 | | 210 | | 269 | | 330 | | |
| 25 | .07 | 87 | .24 | 149 | .41 | 211 | .58 | 270 | .74 | 331 | | |
| 26 | | 88 | | 150 | | 212 | | 271 | | 332 | .91 | |
| 27 | | 89 | | 151 | | 213 | | 272 | | 333 | | |
| 28 | | 90 | | 152 | | 214 | | 273 | .75 | 334 | | |
| 29 | .08 | 91 | .25 | 153 | .42 | 215 | .59 | 274 | | 335 | .92 | |
| 30 | | 92 | | 154 | | 216 | | 275 | | 336 | | |
| 31 | | 93 | | 155 | | 217 | | 276 | | 337 | | |
| 32 | | 94 | | 156 | | 218 | | 277 | .76 | 338 | | |
| 33 | .09 | 95 | .26 | 157 | .43 | 219 | .60 | 278 | | 339 | .93 | |
| 34 | | 96 | | 158 | | 220 | | 279 | | 340 | | |
| 35 | | 97 | | 159 | | 221 | | 280 | | 341 | | |
| 36 | .10 | 98 | .27 | 160 | .44 | 222 | .61 | 281 | .77 | 342 | | |
| 37 | | 99 | | 161 | | 223 | | 282 | | 343 | .94 | |
| 38 | | 100 | | 162 | | 224 | | 283 | | 344 | | |
| 39 | | 101 | | 163 | | 225 | | 284 | .78 | 345 | | |
| 40 | .11 | 102 | .28 | 164 | .45 | 226 | .62 | 285 | | 346 | .95 | |
| 41 | | 103 | | 165 | | 227 | | 286 | | 347 | | |
| 42 | | 104 | | 166 | | 228 | | 287 | | 348 | | |
| 43 | .12 | 105 | | 167 | | 229 | | 288 | .79 | 349 | | |
| 44 | | 106 | .29 | 168 | .46 | 230 | .63 | 289 | | 350 | .96 | |
| 45 | | 107 | | 169 | | 231 | | 290 | | 351 | | |
| 46 | | 108 | | 170 | | 232 | | 291 | | 352 | | |
| 47 | .13 | 109 | .30 | 171 | .47 | 233 | .64 | 292 | .80 | 353 | | |
| 48 | | 110 | | 172 | | 234 | | 293 | | 354 | .97 | |
| 49 | | 111 | | 173 | | 235 | | 294 | | 355 | | |
| 50 | | 112 | | 174 | | 236 | | 295 | .81 | 356 | | |
| 51 | .14 | 113 | .31 | 175 | .48 | 237 | .65 | 296 | | 357 | .98 | |
| 52 | | 114 | | 176 | | 238 | | 297 | | 358 | | |
| 53 | | 115 | | 177 | | 239 | | 298 | | 359 | | |
| 54 | .15 | 116 | .32 | 178 | .49 | 240 | | 299 | .82 | 360 | | |
| 55 | | 117 | | 179 | | 241 | .66 | 300 | | 361 | .99 | |
| 56 | | 118 | | 180 | | 242 | | 301 | | 362 | | |
| 57 | | 119 | | 181 | | 243 | | 302 | | 363 | | |
| 58 | .16 | 120 | .33 | 182 | .50 | | | 303 | .83 | 364 | | |
| 59 | | 121 | | 183 | | | | 304 | | 365 | 1.00 | |
| 60 | | 122 | | 184 | | | | | | 366 | | |

The details of the very involved procedures used need not be explained here; it is anticipated that a variety of computational technics can be invented for effective utilization of the information shown graphically in figures 3 and 4.

For one male monkey with a dental formula of

$$\frac{dc \quad di_2 \quad di_1 \mid di_1 \quad di_2 \quad dc}{di_2 \quad di_1 \mid di_1 \quad di_2}$$

at the time of the (fictitious) initial examination, calculations based on the emergence records of the remaining five pairs of teeth, analyzed with the aid of figure 3, yielded 0.17 year as the age span between birth and the (fabricated) date of acquisition of the animal. A check with the full record showed that the actual age at the time the animal (supposedly) was received was 0.02 year more.

In a similar trial with the record of another male monkey, in which the incisor data were left out of the calculations, solving for $x$ gave a figure that was one half of one-hundredth of a year in error.

The two examples just mentioned should not be taken as evidence that equally small errors will be made in any future trials in estimating postnatal ages from incomplete serial records on odontiasis. The examples should be looked upon as merely auguring well for the arrival of a new era in deciphering the meaning of fragmentary emergence records. Biometric norms of the type illustrated in figures 3 and 4 appear destined to play an important role in the decoding of such incomplete records.

The skill displayed in exploiting the general rule, according to which there is a number of positive intercorrelations between the various anatomical units of a developing dentition, will determine the degrees of success achieved in estimations of age based on data on a few teeth. Until the methodology of such exploitation is formalized in great detail, allowance must be made for the ability of the individual worker. Moreover, since it is very likely that a small percentage of animals will deviate from the common growth and tooth emergence patterns, a few erroneous estimates should be expected when dealing with a large number of individuals. Of course, it is still possible that technics for recognizing such deviants will be invented.

The lack of biometric norms for different stages in the development of the roots of teeth is a handicap that should be removed. With such norms, and the aid of roentgenograms, the accuracy of estimating the age of captured young wild monkeys could be improved further. Also, pre- and post-emergence norms would enable the scientist to assign provisional ages to animals during the outwardly quiescent period between the time of completion of the full deciduous dentition and that of the commencement of permanent tooth emergence during the second year of life.

The biometric norms obtained from the present investigation probably apply to all macaques reared in captivity, at least in this country. In view of the fact that, as yet, no breed, variety, or strain has been developed for *Macaca mulatta* (*29*, p. 28), there is no need for serious concern over the limitations imposed by such considerations.

The wide ranges of variation in tooth emergence do, however, stress the necessity for exercising caution, if more homozygous colonies are created by repeated inbreeding of animals characterized by unusual eruption patterns. It is conceivable, for instance, that several generations of matings restricted to monkeys with unusually early emergence of teeth eventually will result in a breed for which new biometric norms of odontiasis must be computed.

## SUMMARY

The authors present their philosophy on the role of biometrics in promoting an understanding of the phenomenon of tooth emergence. In order to do that more effectively, the reader is given a detailed exposition of the unique and extensive dental data gathered on the large colony of "rhesus" monkeys reared in captivity at Yale University since 1931. Records on ninety-nine individual monkeys form the basic material of the analyses described.

The academic importance of the problem is pointed out, and the theoretical and practical implications of the findings are discussed in several connections throughout the paper. Special attention is given to the employment of dental records and biometric norms of odontiasis in developing technics for estimating the age of young animals with no recorded birth dates.

Contrary to prevalent views, teeth in the process of emergence can serve as a highly refined guide for the estimation of age of normal healthy animals, if proper attention is paid to certain procedural details. How single dental examinations should be interpreted in order to yield the most information is also explained.

Of interest to biometricians are the employment of a hundredth of a year as a unit of measurement and the technic of utilizing the cumulative percent-

age curve so as to assure the derivation of correct values in computing standard deviations of tooth emergence. The discovery that the standard deviations are not altered appreciably even if the time of conception, instead of the date of birth, is treated as the zero point on the age scale was not anticipated. The writers provide an explanation which reconciles these seeming incompatibles. They also call attention to the peculiar usefulness of chronologic asymmetry in certain calculations.

The literature on the subject of tooth emergence is shown to be inadequate. Even the best contributions now available cannot serve as acceptable prototypes for further studies, although some of them deal effectively with special aspects of the total problem. An attempt is made to indicate how future studies should be planned to insure the attainment of scientifically desirable objectives in this field of general biology.

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